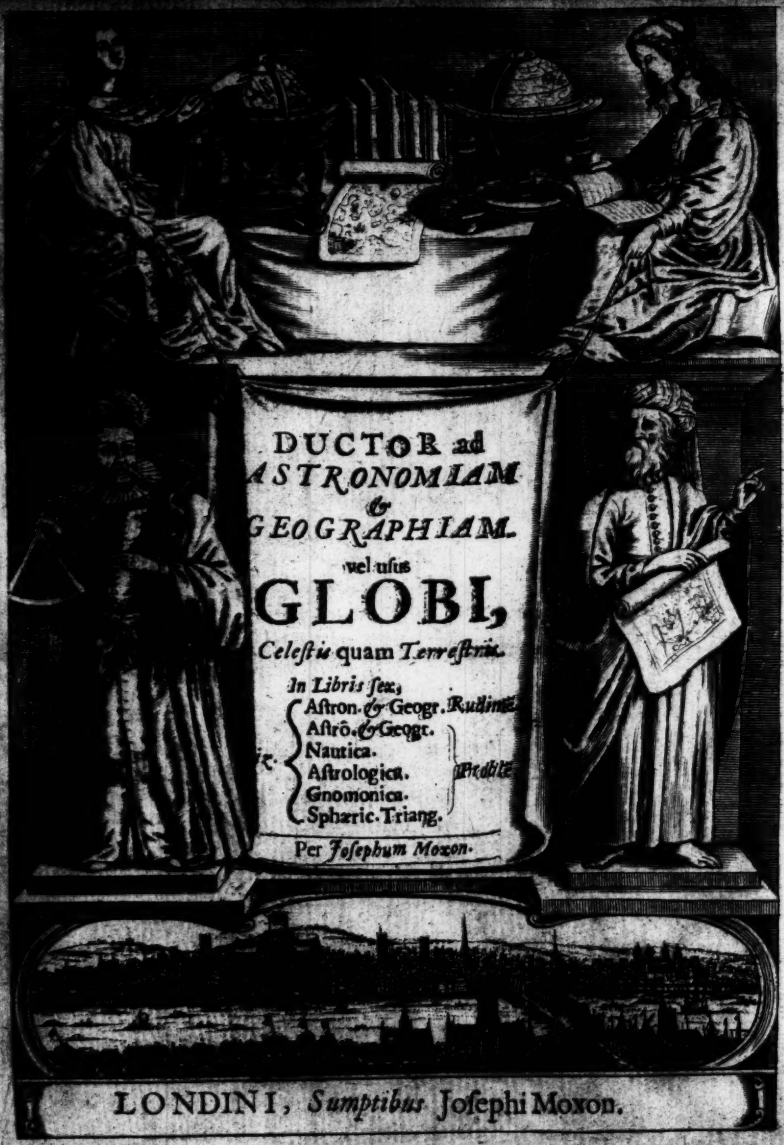
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&
GEOGRAPHIAM.
vel usus
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Celestis quam Terrestris.
In Libris sex,
Astron. & Geogr. Rudim.
Astrō. & Geogr.
Nautica.
Astrologica.
Gnomonica.
Spharic. Triang.
Per Josephum Moxon.
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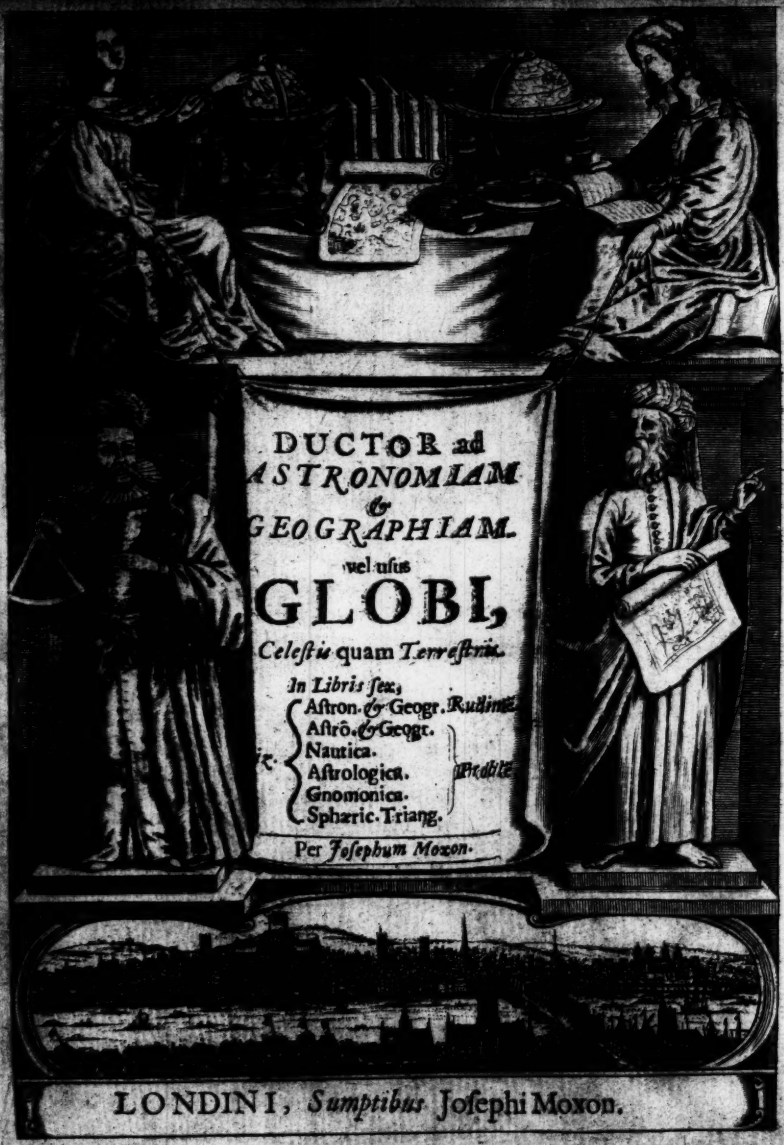
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A TUTOR to
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Or an Eaſie and ſpeedy way to know the Uſe of both the

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As alſo a Diſcourſe of *the Antiquity, Progreſs and Augmentation of Aſtronomie*.

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Job. 26. 13. *By his Spirit he hath garniſhed the Heavens: His hand hath framed the crooked Serpent.*

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# To the Reader.

Courteous Reader,

*Formerly Printed a Book of the Uſe of the Globes, Intituled* A Tutor to Aſtronomy and Geography: *The Book was Compoſed by* William Blaew, *but the Title was mine own; and therefore I hope I may be the bolder to uſe it when and where I liſt. The ſale of that Impreſſion had almoſt perſwaded me to have Printed it again: But when I conſidered it wanted many neceſſary Problemes, both in* Aſtronomy, Navigation, Aſtrology, Dyalling, *and the whole* Doctrine of Triangles *by the Globe; And alſo that the Examples throughout that Book were made for the Citty of* Amſterdam; *which by the general ſale of the Book I found rendred it leſs acceptable then it would have been if they had been made for* London; *And when I conſidered that to add ſo many Problemes, and alter all the Examples would both Metamorphoſe that Book, and be as Laborious a work to me as if I ſhould write a new one; Then I reſolved to take this Task upon me; which at length with Gods Aſſiſtance I have finiſhed; And now expoſe it to thy acceptance.*

*The Globes is the firſt Studie a Learner ought to undertake: for without a competent knowledge therein he will never be able to underſtand any Author either in* Aſtronomy, Aſtrology, Navigation, *or* Trigonometry: *Therefore my aim hath been to make the Uſe of them very plain and eaſie to the meaneſt Capacities: In proſecution of which Deſigne, I doubt the Learneder ſort may be apt to Cenſure me guilty of Prolixity, if not Tautology: Becauſe the Precepts being plain, they may account ſome of the Examples Uſeleſs. But I deſire them to conſider that I write not to expert Practitioners, but to Learners; to whom Examples may prove more Inſtructive then Precepts. Beſides, I hope to encourage thoſe by an ample liberal plainneſs to fall in love with theſe Studies, that formerly have been diſheartned by the Crabbed brevity of thoſe Authors that have (in Characters as it were) rather writ Notes for their own Memories, then ſufficient Documents for their Readers Inſtructions.*

*The Globes for which this Book is written are the Globes I set forth about four years ago: which as I told you in my Epistle to the Reader of* Blaew's *Book differs somewhat from other Globes, and that both the* Cœlestial *and the* Terrestrial; *mine being the latest done of any, and to the accomplishing of which, I have not only had the help of all or most of the best of other Globes, Maps, Plats; and Sea-drafts, of New Discoveries that were then extant, for the* Terrestrial Globe, *but also the Advice and directions of divers learned and able Mathematicians both in* England *and* Holland *for Tables and Calculations both of Lines and Stars for the* Cœlestial: *upon which Globe I have placed every Star that was observed by* Tycho Brahe *one degree of Longitude farther in the Ecliptick then they are on any other Globes: So that whereas on other Globes the places of the Stars were correspondent with their places in Heaven* 58. *Years ago, when* Tycho *observed them, and therefore according to his Rule want about* 47. *minutes of their true places in Heaven at this Time: I have set every Star one degree farther in the Ecliptick, and Rectified them on the Globe according to the true place they will have in Heaven in the Year* 1671.

*On the* Terrestrial Globe *I have inserted all the New Discoveries that have been made, either by our own or Forraigne Navigators, and that both in the East, West, North, and South, parts of the Earth. In the* East Indies *we have by these later Times many spacious Places discovered, many Ilands inserted, and generally the whole Draft of the Country rectified and amended, even to the Coast of* China, Japan, Giloli, *&c. In the* South Sea *between the* East *and* West Indies *are scattered many Ilands, which for the uncertain knowledge former Times had of them are either wholely left out of other Globes, or else laid down so erroneously that little of credit can be attributed unto them:* California *is found to be an Iland, though formerly supposed to be part of the main Continent, whose North West shoar was imagined to thrust it self forth close to the Coasts of* Cathaio, *and so make the supposed* Straits of Anian. *The Western Shoars of the* West Indies *are more accurately discribed then formerly, as you may see if you compare my Terrestrial Globe with the Journals of the latest Navigators: And if you compare them with other Globes you will find* 5, 6, *yea* 7. *degrees difference in Longitude, in most Places of these Coasts.* Magellanica *which heretofore was thought*

*to*

*to be part of the South Continent called* Terra Incognita *is now alſo found to be an Iland. All that Track of Land called* Terra Incognita *I have purpoſely omitted, becauſe as yet we have no certainty whether it be Sea or Land, unleſs it be of ſome parts lately found out by the Dutch; who having a convenient Port at* Bantam *in* Java, *have from thence ſent forth Ships Southwards, where they have found ſeveral very large Countries; one whereof they have called* Hollandia Nova, *another* Zelandia Nova, *another* Anthoni van Diemans *Land; and divers others; ſome whereof lies near our* Antipodes; *as you may ſee by my Terreſtrial Globe. Again, Far to the Northwards there are ſome New Diſcoveries, even within 6. degrees of the Pole: The Drafts to the* North Eaſtwards *I have laid down even as they were diſcribed by the Searchers of theſe Parts, for a Paſſage into the* Eaſt Indies. *And alſo the Diſcoveries of* Baffin, *Capt.* James, *and Capt.* Fox, *(our own Country men that attempted the finding a paſſage that way into the South Sea.*

*I alſo told you what difference there is in ſeveral Authors about placing their firſt Meridian, which is the beginning of Longitude; that* Ptolomy *placed it at the* Fortunate Ilands, *which Mr* Hues pag. 4. chap. 1. *in his Treatiſe of Globes proves to be the Ilands of* Cabo Verde, *and not thoſe now called the* Canary Ilands; *becauſe in his Time they were the furtheſt Places of the Diſcovered World towards the Setting of the Sun: Others placed it at* Pico *in* Teneriffa; *Others at* Corvus *and* Flora; *becauſe under that Meridian the Compaſs had no* Variation, *but did then duely reſpect the North and South; Others for the ſame Reaſon began their Longitude at St* Michaels; *and others between the Ilands of* Flores *and* Fayal: *And the Spaniards of late by reaſon of their great Negotiation in the* Weſt Indies, *have begun their Longitude at* Toledo *there, and contrary to all others account it Weſtwards.*

*Therefore I ſeeing ſuch diverſity among all Nations, and as yet a Uniformity at home, choſe with our own Country men to place my Firſt Meridian at the Ile* Gratioſa, *one of the Iles of the* Azores.

*By the different placing of this firſt Meridian it comes to paſs that the Longitude of places are diverſly ſet down in different Tables: For thoſe Globes or Maps that have their firſt Meridian placed to the Eaſtwards of* Gratioſa *have all places counted Eaſtward between the firſt Meridian and the Meridian of* Gratioſa

tiosa *in fewer degrees of Longitude: And those Globes and Maps that have their first Meridian placed to the Westwards, have all Places counted Eastwards from the Meridian of* Gratiosa *and their first Meridian in a greater number of degrees of Longitude, and that according as the Arch of Difference is.*

*I have annexed a smal Collection out of Dr* Hood, *which declares the Reason why such strange Figures and Forms are pictured on the Celestial Globe: and withall the Poetical Stories of every Constellation.*

*I also thought good to add at the latter end of this Book a smal Treatise, intituled* The Antiquity, Progress, and Augmentation of Astronomy. *I may without Partiallity give it the Encomium of a Pithy, Pleasant, and Methodical peece: It was written by a Learned Author; and is worthy the Perusal of all Ingenuous Lovers of these Studies.*

Joseph Moxon.

---

*Encomiastic Achrosticon* Authoris.

JTs now since *Atlas* raign'd thousands of Years,
OF whom 'tis Fabl'd, Heavens hee did Uphold,
SO Ancient Authors write: But it appeares
EXcell he others did, for we are told
PRoject he did the *Sphear*: and for his Skil
HE had therein, his Fame will Flourish still.
MUst we not also Praise in this our Age
OUr Authors skill, and Pains, who doth ingage
XThousand Thanks, not for this Book alone
OF his, But for the *Globes* he makes there's none
NOw extant made so perfect: This is known

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*Being the first* RUDIMENTS *of*

# Astronomy & Geography.

Or

*A Description of the* Lines, Circles, *and other Parts of the* GLOBE.

## PRÆFACE.

THe Students of all Arts and Sciences have ever proposed a Maxime, whereon (as on an allowed Truth) the whole Science hath dependance: and by so much the more demonstrable that Maxime is, so much the more of Excellency the Science may claim.

This of Astronomy and Geography comes not behind any; for herein we shall only admit (with the Ancients) that the Form of the visible World is Spherical: Neither shall we beg our Ascertion any farther then Occular Appearance will demonstrate: every Mans Ey being his Judge, if he be either on a Plain field, or at Sea, where nothing can hinder a free inspection of the Horizon.

Upon good grounds therefore they ascerted the Spherical form of the Whole: and also concluded the Parts to be Round: I meane, very intire Subsistence, as the Stars, Planets, and the Earth. In the Celestial Bodies (as the Stars and Planets) this is also visible; and therefore un-controullable: But that the Earth is Round proves with the unskilfull matter of di-

 spute.

*ſpute; they frequently objecting with S.* Auſtine *the words of the Scripture, which ſay,* He hath ſtretched forth the corners of the Earth; *not conſidering whether thoſe words were ſpoken as alluding to the amplitude of Gods Omnipotence; or that the Corners were meant* Capes *of* Land, *which indeed are ſtretched forth into the Sea. But that the Earth is Round is proved by divers certain and infallible Reaſons,*

*As firſt, By the Navigations of our Age, Divers able and honeſt Mariners having Sailed and continued an Eaſterly Courſe, have at length arrived (without turning back) to the ſame place from whence they ſet forth: witneſs* Magellanicus, *Sr.* Francis Drake, Tho. Cavendiſh, Oliver van-der Noort, W. Schouten, *&c.*

*Secondly, By the length of degrees in every Parallel; for it is found by Dayly obſervation that the degrees of every Parallel upon the Earth, hold the ſame proportion to the degrees of the Equinoctial, as the degrees of the ſame Parallel upon an Artificial Globe or Sphear do to the degrees of the greateſt Circle of the ſame: This Argument alone is ſufficient: yet take one more from Viſible Appearance: And that is this: The ſhadow which the Earth and Water together make in the Eclipſe of the Moon is alwaies a part of a Circle; therefore the Earth and Water which is the Body ſhadowing muſt alſo be a Circular or round Body; for if it were three ſquare, four ſquare, or any other form, then would the ſhadow which it mvkas in the Moon be of the ſame faſhion.*

*Beſides, Of all figures the Sphear or Globe is moſt perfect, moſt Capacious, and moſt intire of it ſelf, without either joynts or Angles; which form we may alſo perceive the* Sun, Moon, *and* Stars *to have, and all other things that are bounded by themſelves, as Drops of Water, and other liquid things.*

*But there is another frequent Argument againſt the Globulus form of the Earth; and that is, That it ſeems impoſſible*

*poſſible that the Earth ſhould be round, and yet alſo Inhabible in all Places: For though we that inhabite on the top of the Earth go with our heads upwards; yet thoſe that inhabite underneath us muſt needs go with their Heads downwards, like Flyes on a Wall or Ceeling; and ſo be in danger of falling into the* Air.

*For Anſwer hereunto, firſt, You muſt underſtand that in the Center of the Earth there is an Attractive and drawing power, which draws all heavy ſubſtances to it: by vertue of which Attractive power, things though looſed from the Earth will again incline and cling to the Earth, and ſo much the more forcibly, by how much the heavier they are; as a bullet of Lead let fall out of the Air, inclines towards the Earth far more violently and ſwiftly then a bullet of the ſame bigneſs of Wood, or Cork.*

*Secondly, you muſt underſtand that in reſpect of the whole Vniverſe there is no part either upper or under, but all parts of the Earth are alike incompaſt with Heaven; yet in reſpect of the Earth, it is Heaven, which we take for the upper part; and therefore we are ſaid to go with our heads upwards, becauſe our head (of all the parts of our body) is neareſt to Heaven.*

*Now that this Attractive power lies in the Center of the Earth, is proved by this Argument: If the Attractive power were not in the Center, a Plumb-line let fall would not make Right Angles with the Superficies of the Earth; but would eb Attracted that way the Attractive vertue lies, and ſo make unequal Angles with the Superficies: But by ſo many Experiments as hath yet been made, we find that a Plumb-line continued, though never ſo deep, yet it alters no Angles with the Superficies of the Earth; and therefore undoubtedly the Attractive power lies in the very Center, and no where elſe.*

## Chap. I.

### I. *What a* Globe *is.*

A Globe according to the Mathematical Definition, is a perfect and exact round Body contained under one ſurface.

Of this form (as hath been proved) conſiſts the Heavens and the Earth: and therefore the Ancients with much pains Study and Induſtry, endeavouring to imitate as well the imaginary as the real appearances of them both, have Invented two Globes; the one to repreſent the Heavens, with all the Conſtellations, fixed Stars, Circles, and Lines proper thereunto, which Globe is called the *Celeſtial Globe*; and the other with all the Sea Coaſts, Havens, Rivers, Lakes, Cities, Towns, Hills, Capes, Seas, Sands, &c. as alſo the Rhumbs, Meridians, Parallels, and other Lines that ſerve to facilitate the Demoſtration of all manner of Queſtions to be performed upon the ſame: and this Globe is called the *Terreſtrial Globe.*

### II. *Of the two* Poles.

Every Globe hath two Poles, the one North, the other South. The North Pole is in the North point of the Globe: The South Pole in the South point.

### III. *Of the* Axis.

From the Center of the Globe both waies, proceeds a line through both the Poles, and continues it ſelf infinitely; which is called the *Axis of the World*; and is repreſented by the two wyers in the Poles of the Globe: Upon theſe two wyers the Globe is turned round, even as the Heavens is imagined to move upon the *Axis* of the World.

### IIII. *Of the* Braſen Meridian.

Every Globe is hung by the *Axis* at both the Poles in a Braſen Meridian, which is divided into 360 degrees; (or which is all one) into 4 Nineties: the firſt beginning at the North Pole, is continued from the left hand towards the right till the termination of 90 degrees, and is marked with 10, 20, 30, &c. to 90. from whence the degrees are numbred with 80, 70, 60, &c. to 0. which is in the South Pole: from whence again the degrees are numbred with

with 80,70,60,&c. to 0, and laſtly, from 0 the degrees are numbred with 10,20,30, to 90. which is again in the North Pole.

This Braſen Meridian is of great uſe; for by help of it you may find the Latitude of all Places, the Declination of all the Stars, &c, and rectifie the Globe to any Latitude.

## V. *Of the* Horizon.

The Horizon is a broad wooden Circle, encompaſſing the Globe; having two notches in it; the one in the North the other in the South point. The notches are made juſt fit to contain the Braſen Meridian that the Globe is hung in: In the bottom or under Plane of the Horizon there ſtands up a rop or (as it is called) a *Bed*, in which there is alſo a notch, into which notch the Braſen Meridian is alſo let, ſo lo, as that both it and the Globe may be divided into two equal halfs by the upper Plane of the wooden Horizon. Theſe Notches are as gages to keep the Globe from inclining more to the one ſide of the wooden Horizon then the other.

Upon the upper Plane of the Horizon is ſeveral Circles delineated: as firſt, the inner Circle, which is a Circle divided into twelve equal parts, *viz.* into twelve *Signes*; every Signe having its name prefixed to it; as to the Signe of ♈ is the word *Aries*; to ♉ the word *Taurus*, &c. every Signe is again divided into 30 equal parts, which are called Degrees, and every tenth degree is marked with 10, 20, 30.

Next to the Circle of Signes is a Kalender or Almanack, according to the Old ſtile uſed by us here in *England*, each Moneth being noted with its proper Name; as *January*, *February*, *March*, *&c.* and every day diſtinguiſhed with Arithmetical figures, as 1, 2, 3, 4, &c. to the end of the Moneth.

The other Calender is a Calender of the New ſtile; which is in a manner all one with the Old; only in this Calender the moneth begins ten daies ſooner then they do in the other: and to this Calender (becauſe it was inſtituted by the Church of *Rome*) there is annexed the Feſtival daies Celebrated by the Romiſh Church.

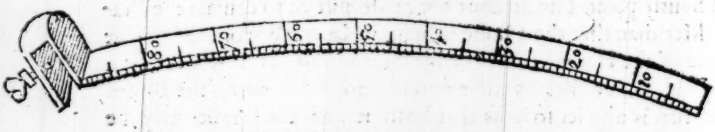
The two other Circles are the Circles of the Winds; the innermoſt having their Greek and Latine names; which by them were but twelve; and the outermoſt having the Engliſh Names, which for more preciſeneſs are two and thirty.

The uſe of the upper Plane of the Horizon is to diſtinguiſh the Day from the Night; the Riſing and Setting of the Sun, Moon, or

Stars, &c. and for the finding the Azimuth, and Amplitude, &c.

## VI. *Of the* Quadrant *of* Altitude.

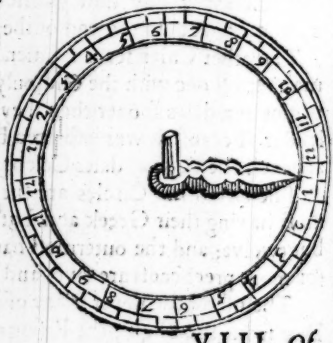
The Quadrant of Altitude is a thin brass plate, divided into 90. degrees; and marked upwards with 10, 20, 30, 40, &c. to 90. It is riveted to a Brass Nut, which is fitted to the Meridian; and hath a Screw in it, to screw upon any degree of the Meridian. When it is used it is screwed to the *Zenith*. Its use



is for measuring the Altitudes, finding Amplitudes, and Azimuths, and discribing Almicantaraths. It would sometimes stand you in good steed if the Plate were longer by the bredth of the Horizon then 90. degrees; for then that length being turned back will serve you instead of an Index, when the Nut is screwed to the Zenith, to cut either the degrees or Daies of either Style, or the Points of the Compass in any of those Circles concentrical to the innermost edge of the Horizon, which the Ey cannot so well judge at.

## VII. *Of the* Hour Circle, *and its* Index.

The Hour Circle is a smal Brasen Circle, fitted on the Meridian, whose Center is the Pole of the world: It is divided into the 24 hours of the Day and Night, and each hour is again divided into halfs and quarters, which in a Revolution of the Globe are all pointed at with an Index, which to that purpose is fitted on the Axis of the Globe.



The use of the hour Circle is for shewing the Time of the several mutations and Configurations of Celestial Appearances.

VIII. *Of*

## VIII. *Of the* Nautical Compaſs, *or* Box *and* Needle.

Juſt under the Eaſt point of the Horizon, upon the undermoſt Plane, is ſometimes fixed a *Nautical Compaſs*, whoſe North and South line muſt be Parallel to the North and South line of the Horizon. The uſe of it is for ſetting the Angles of the Globe correſpondent to the Angles of the World.

## IX. *Of the* Semi-Circle *of* Poſition.

This is a Semi-Circle made of Braſs, and divided into 180. degrees, numbred from the Equinoctial on either ſide with 10, 20, 30, &c. to 90. at the two ends there is an Axis, which is fitted into the two holes of two ſmal ſtuds fixed in the North and South points of the upper Plane of the Horizon: upon this Axis it is moved up and down, according to the intent of your operation.

The uſe of this Circle of Poſition is, for the finding the twelve Aſtrological Houſes of Heaven; and alſo for finding the Circle of Poſition of any Star or Point in Heaven.

Thus much may ſerve for the lineaments Circumjacent to the body of the Globe. The next diſcourſe ſhall be

## Chap. II.

### *Of the* Circles, Lines, *&c. diſcribed upon the* Superficies *of the* Globe; *beginning with the* Terreſtrial Globe; *and*

### I. *Of the* Equator.

The *Equator* is *a great Circle*, encompaſſing the very middle of the Globe between the two Poles thereof, and divides it into two equal parts, the one the North part, and the other the South part. It is (as all great Circles are) divided into 360. equal parts, which are called Degrees. Upon this Circle the Longitude is numbred, from Eaſt to Weſt: and from this Circle both waies, *viz.* North and South the Latitude is reckoned. It is called the Equator, becauſe when the Sun comes to this line (which is twice in one year, to wit, on the tenth of *March*, and the eleventh of

of *June*) the Daies and Nights are equated, and both of one length.

## II. *Of the* Meridians.

There are infinite of Meridians, for all places lying Eaſt or Weſt from one another have ſeveral Meridians; but the Meridians delineated upon the Terreſtrial Globe are in number 36. ſo that between two Meridians is contained ten degrees of the Equator. From the firſt of theſe Meridians(which is divided into twice 90 degrees)accounted from the Equator towards either Pole)is the beginning of Longitude,which upon our Engliſh Globes is at the Ile *Gratioſa*,one of the Iles of the *Azores*,and numbred in the Equator Eaſtwards, with 10, 20, 30, &c. to 360. round about the Globe, till it end where it began.

They are called Meridians,becauſe they divide the Day into two equal parts: for when the Sun comes to the Meridian of any Place, it is then Midday, or full Noon.

## III. *Of the* Parallels.

As the Meridians are infinite, ſo are the Parallels; and as the Meridian lines delineated upon the Globe are drawn through no more then every tenth degree of the Equator,ſo are the Parallels alſo delineated but upon every tenth degree of the Meridian;leſt the Globe ſhould be too much filled with ſuperfluity of lines, which might obſcure the ſmal names of Places. The Parallel Circles run Eaſt and Weſt round about the Globe, even as the Equator; only the Equator is a great Circle; and theſe are every one leſs then other, diminiſhing gradually till they end in the Pole. The Parallels are numbred upon the Meridian with 10,20, 30,&c. to 90. beginning in the Equator, and ending in the Pole.

They are called Parallels;becauſe they are Parallel to the Equator.

## IIII. *Of the* Ecliptick, Tropicks, *and* Polar Circles.

Theſe Circles though they are delineated upon the Terreſtrial Globe, yet they are moſt proper to the Celeſtial; and therefore when I come to the Celeſtial Globe, I ſhall define them unto you.

## V: *Of the* Rhumbs.

The Rbumbs are neither Circles nor ſtraight lines, but Heliſpherical or Spiral lines: They proceed from the point where we ſtand, and wind about the Globe till they come to the Pole; where at laſt they looſe themſelves. They repreſent the 32 winds of the Compaſs.

Their uſe is to ſhew the bearing of any two places one from another: that is to ſay, upon what point of the Compaſs any ſhoar or Land lies from another.

There are many of them deſcribed upon the Globe, for the better directing the ey from one ſhoar to the other, when you ſeek after the bearing of any two Lands. Some of them (where there is room for it) have the figure of the *Nautical Card* drawn about the Center or common interſection, and have (as all other Cards have) for the diſtinction of the North point, a *Flowerdeluce* pictured thereon.

They were firſt called Rumbs by the *Portugals*; and ſince uſed by Latine Authors, and therefore that name is continued by all Writers that have occaſion to ſpeak of them.

## VI. *Of the* Lands, Seas, Ilands, *&c. Deſcribed upon the* Terreſtrial Globe:

The Land deſcribed upon the Globe is bounded with an irregular line, which runs turning and winding into Creeks and Angles, even as the ſhoar which it repreſents (doth) For the better diſtinction of Lands, &c. this line is cullered cloſe by one ſide thereof with divers Cullers, as with red, yellow, green, &c. theſe cullers diſtinguiſh one part of the Continent from the other; and alſo one Iland from another. That ſide of the line which incompaſſes the Cullers, is the bounds of the Land; the other ſide of the line which is left bare without Cullers, is the limits of the Water.

The *Land* is either *Continents*, or *Ilands*.

A *Continent* is a great quantity of *Land*, not interlaced or ſeparated by the *Sea*, in which many *Kingdomes* and *Principalities* are contained; as *Europe*, *Aſia*, *Affrica*, *America*.

An *Iſland* is a part of the *Earth*, environed round with *Waters*; as *Britain*, *Java*, *S. Laurence Iſle*, *Barmudas*, &c.

Theſe again are ſub-divided into *Peninſula*, *Iſtmus*, *Promontorium*.

A *Peninsula* is almost an *Island*; that is, a track of *Land* which being almost encompassed round with *Water*, is joyned to the firm *Land*, by some little *Isthmus*; as *Molacca* in the *East-Indies*, &c.

An *Isthmus* is a little narrow neck of *Land*, which joyneth any *Peninsula* to the Continent; as the Straits of *Darien* in *Peru*, and *Corinth* in *Greece*.

*Promontorium*, is some high Mountain, which shooteth it self into the *Sea*, the utmost end of which is called a *Cape*, as that great *Cape of Good Hope*, and *Cape Verde* in *Africa*.

The *Water* is either *Ocean*, *Sea*, *Straits*, *Creeks*, or *Rivers*.

The *Ocean* is that generall collection of all *Waters*, which invironeth the whole *Earth* on every side.

The *Sea* is a part of the *Ocean*; to which we cannot come, but through some Strait, as *Mare Mediterraneum*, *Mare Balticum*, and the like.

These two take their names either from the adjacent places, as the Brittish Ocean, the *Atlantick Sea*, &c. or from the first discovere as *Mare Magellanicum*; *Davis*, and *Forbishers Staits*; &c. Or from some remarkable accident, as *Mare Rubrum*, from the red colour of the Sands; *Mare Ægeum*, *Pontus Euxinus*, and the like.

A *Strait*, is a part of the Ocean restrained within narrow bounds, and opening a way to the *Sea*; as the *Straits* of *Gibralter*, *Hellespont*, &c.

A *Creek* is a crooked shoar, thrusting out as it were two armes to imbrace the *Sea*, as *Sinus Adriaticus*, *Sinus Persicus*, &c.

A *River* is a small branch of the *Sea*, flowing into the *Land*; as *Thames*, *Tiber*, *Rhine*, *Nilus*, &c.

Now that these Lands, Ilands, Towns, Seas, Rivers, &c. may at the first search be found upon the Globe, all Geographers have placed them thereon according to Longitude, and Latitude,

## VII. *Longitude.*

The Longitude is an Arch of the Equator, comprehended between the first Meridian and the Meridian of the Place you inquire after. It is numbred on the Equator from the West to the East-

Eastwards, with 10, 20, 30, to 360. degrees, till it end where it began.

## VIII. *Latitude.*

The Latitude is an Arch of the Meridian, comprehended between the Equator and the place enquired after. It is numbred on the Meridian, from the Equator both waies, *viz.* North and South, till it come to the Poles, or 90 degrees.

Thus much may serve for the description of the *Terestrial Globe*: I therefore come to treat of the Celestial.

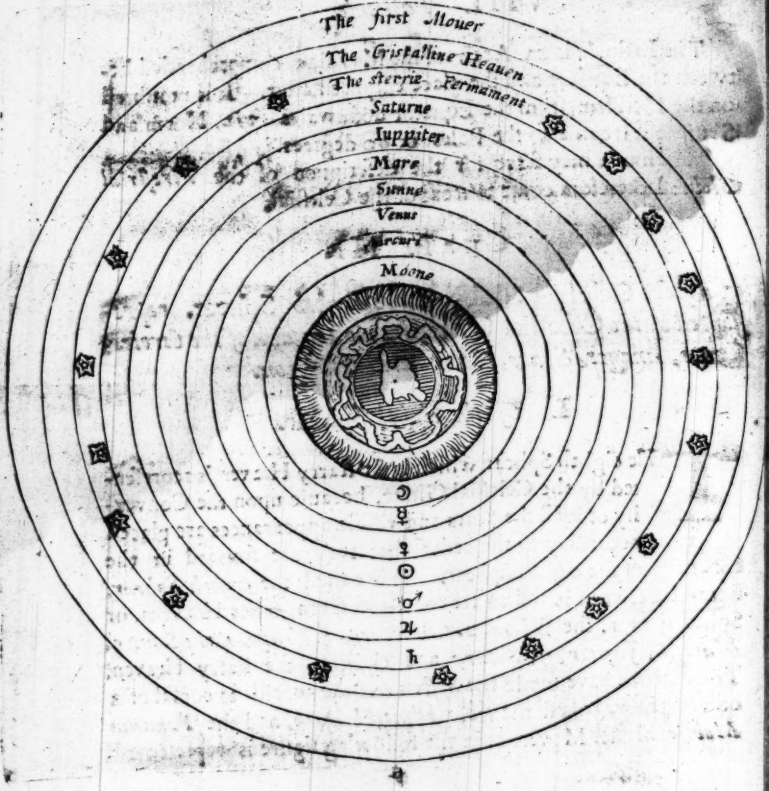
# CHAP. III.

## *Of the* Celestial Globe, *or the Eighth* Sphear, *represented by the* Celestial Globe: *its motion, and of the Circles, Lines, Images, Stars, &c. described thereon.*

### I. *Of the eighth* Sphear.

THe eighth Sphear which is the starry Heaven, is represented by the Celestial Globe, because upon the Convexity of it all the Stars and visible appearances are placed according to the order that they are situated in the concavity of the eighth Sphear. It is called the *eighth Sphear*, because between it and us are contained seven other Heavens, or Sphears; as 1. the *Moon*, 2. *Mercury*, 3. *Venus*, 4. *the Sun*, 5. *Mars*, 6. *Jupiter*, 7. *Saturn*. and eighthly the starry Heaven. The antients have made the *Systeme* of the world to consist of 2 other *Sphears*, called the *Chiristiline Heaven*, and the *Primum Mobile*, or first Mover: as in the following figure is represented.

*A figure wherein may be seen the Composition of the whole frame of the World.*




## II. *Of the Motion of the eighth* Sphear.

There hath bin attributed to the eighth Sphear a twofold motion; the one called its *Diurnal Motion*, which is made from East to West. upon the Poles and Axis of the World: And the other called its *Second motion*, which is made from West to East upon the Poles and Axis of the Ecliptick.

The *Diurnal motion* is caused by the violent Motion of the *Primum*

*Primum Mobile*; for in 24 hours it carries along with it, not only the eighth Heaven or Orb of fixed Stars, but the Orbs of the *Sun*, the *Moon*, and all the reſt of the Planets. It is called the *Diurnal Motion* becauſe it is finiſhed in one Day.

The ſecond Motion is unproperly attributed to the eighth Sphear; it being indeed the Motion of the Equinoctiall, tho Authors ſometimes careleſly mention the one inſteed of the other. Therefore in the next Section, where I treat of the Equinoctial, I ſhall at large explain unto you the nature of this miſ-called *Second Motion*.

## III. *Of the* Equinoctial.

The Equinoctial upon the Celeſtial Globe, is the ſame line formerly called the Equator upon the Terreſtrial; only with this difference, that the Equator remains fixt upon the Terreſtrial Globe, but the Equinoctial upon the Celeſtial Globe is moveable; (or at leaſt muſt be imagined to move) contrary to the *Diurnal motion* from Weſt to Eaſt, upon the Poles of the Ecliptick: I ſay imagined to move, becauſe in the Heavens it doth really move, tho on a material Globe it would be inconvenient to make a moveable Equinoctial, and therefore it hath one fixed: which for this and the next age will ſufficiently ſerve, without much deviation from the truth it ſelf.

Now that the difference between the Equator upon the Terreſtrial Globe, and the Equinoctial upon the Celeſtial, may be proved; and the motion of the Equinoctial be the better underſtood; I ſhall only bring this example,

All places that were formerly under the Equator, do and will keep the ſame Longitude, and remain ſtill under the Equator: as may be proved by comparing the Ancient and modern *Geographers* together: but thoſe Stars that were formerly under the Equinoctial, do not keep the ſame Longitude, nor remain under the Equinoctial: becauſe the Equinoctial (as aforeſaid) hath a motion from Weſt to Eaſt, upon the Poles of the Ecliptick. But the Stars being fixed in their one Sphear, like knots in wood, and therefore move not, are by the Preceſſion of the Equinox left behind the Equinoctial Colure, and ſo are cauſed to alter their Longitude; as by comparing the Obſervations of ancient and modern *Aſtronomers* together, it will appear: for about 346

years before Christ, the first Star in the *Rams horn* was by the *Egyptian* and *Grecian* Astrononiers observed to be in the Equinoctial Colure: and 57 years ago, when *Tycho* observed, it was found to be in 27 degrees 37 minutes of ♈. So that in about 2000 years it is moved forwards 28 degrees, and will according to *Tycho's* opinion, finish its Revolution in 25412 years: According to which motion, I have Calculated this following Table, for finding the Degrees and Minutes of the Equinoctial motion, answerable to any number of years within the said Revolution.

| ye. | deg. | m | years. | deg. | m. |
|---|---|---|---|---|---|
| 1 | 0 | 0 3/4 | 100 | 1 | 25 |
| 2 | 0 | 1 1/2 | 200 | 2 | 50 |
| 3 | 0 | 2 1/4 | 300 | 4 | 15 |
| 4 | 0 | 3 | 400 | 5 | 40 |
| 5 | 0 | 4 1/4 | 500 | 7 | 5 |
| 6 | 0 | 5 | 1000 | 14 | 10 |
| 7 | 0 | 5 3/4 | 2000 | 28 | 20 |
| 8 | 0 | 6 1/2 | 3000 | 42 | 30 |
| 9 | 0 | 7 1/4 | 4000 | 56 | 40 |
| 10 | 0 | 8 1/2 | 5000 | 70 | 50 |
| 20 | 0 | 17 | 10000 | 141 | 40 |
| 40 | 0 | 34 | 20000 | 283 | 20 |
| 60 | 0 | 51 | 25000 | 354 | 10 |
| 80 | 1 | 8 | 25412 | 360 | |

This Table may be of use for finding the Equinoctial position of any Star, for any year either past, present, or to come. Its use is very easie, for if you desire to know the motion of the Equinox for any number of years, you need but seek your number in the Collumn of years, and against it you have the degrees and minutes of the Equinoctial motion.

But tho the Stars have this motion one way, *viz.* in Longitude, yet do they not at all alter their Latitudes; because the motion of the Equinoctial is made upon the Poles of the *Ecliptique*.

IIII.

## IIII *Of the* Ecliptique.

The *Ecliptique* is a great Circle, lying oblique or aſlope from the Equinoctial, making an Angle of 23 ½ degrees with it: It cuts the Equinoctial into two equal parts, and is cut by the Equinoctial in two oppoſite points, *viz.* ♈, and ♎. It divides the Globe into two equal parts, called *Hemiſphears*; the one the Northern and the other the Southern *Hemiſphear*. It is divided into 12 equal parts, which are called the twelve *Signes*, every part being noted with the Character of the *Signes* belonging unto it; as unto *Aries*, ♈: to *Taurus*, ♉: to *Gomini*, ♊; and ſo of the reſt. From every one of theſe 12 diviſions proceed both waies *viz.* North, and South, Circles of Longitude, into the Poles of the *Ecliptique*. Each of theſe twelve *Signes* is divided into 30 equal parts, which are called degrees; and are numbred upon every tenth degree with 10,20, to 30, and upon may new Celeſtial Globe, for more preciſeneſs, every degree is again divided into halfs.

„ It is called the *Ecliptique* as being derived from the Greek „ word; Εκλειπειν which ſignifies to want light, becauſe in and „ about it happen all the defects and Eclipſes both of the Sun „ and the Moon.

„ It is alſo called *the Way of the Sun*, becauſe the Sun goes „ alwaies under it, paſſing through it in all his Annual Courſe.

## V. *Of the* Poles *of the* Ecliptick.

There are two Poles of the Ecliptick, the one the North Pole, the other the South Pole; and are called North or South according to their poſition next the North or South Pole of the World. Each it diſtant from its correſpondent Pole of the World 23 degrees 30 minutes.

As on the Terreſtrial Globe all the Meridians diſcribed thereon meet in the Pole of the World, ſo on the Celeſtial all the Circles of Longitude drawn through the twelve Signes meet in the Poles of the Ecliptick.

VI.

## VI. *Of the* Axis *of the* Ecliptick.

Through the two Poles of the *Ecliptick* is imagined to pass a straight line, through the Center of the Plain of the *Ecliptick*; which is called the *Axis of the Ecliptick*, upon which the *second motion* of the *Ecliptick* is performed: even as the Diurnal motion is performed upon the Axis of the World.

## VII. *Of the* Colures, *and* Cardinal Points.

There are two great Circles cuting one another at right angles in the Poles of the World, which are called the *Colures*. Each *Colure* receives an additional name from the point in the *Ecliptick* that it Cuts; as the one passes from Pole to Pole through the beginning of ♈ and ♎, which being two Equinoctial Signes, name therefore that Colure the *Equinoctial Colure*: The other passes through the beginning of ♋ and ♑, which are Solsticial Signes, and therefore names that the *Solsticial Colure*.

These Colures by intersecting one another, divide themselves into four Semi-circles; and these Semi-circles divide the *Ecliptick* into four equal parts. *viz.* in ♈, ♋, ♎, and ♑.

The points of the Ecliptick that these intersections pass through, are called the *four Cardinal points*, and are of great use in Astronomy; for according to the Suns approach to any of them, the Season of the year is altered into *Spring*, *Summer*, *Autumn*, *Winter*: as shall be shewed hereafter.

## VIII. *Of the* Tropicks.

There are two smaller Circles Parallel to the Equinoctial, which are called the *Tropicks*; the one called the *Tropick of Cancer*, the other the *Tropick of Capricorn*: they are distant from the Equinoctial 23 degrees 30 minutes; and therefore are the bounds of the *Ecliptick*. They receive their names from the Celestial Signe that they are joyned unto; as the one the *Tropick of Cancer*, because it touches the Signe of *Cancer*; the other the *Tropick of Capricorn*, because it touches the Signe of *Capricorn*.

IX.

## IX. *Of the Circles* Arctick *and* Antarctick.

About the Poles of the World are two ſmal Circles deſcribed; the one called the *Arctick*, the other the *Antartick*: That in the North is called the *Arctick Circle*: that in the South the *Antarctick Circle*.

They have the ſame diſtance from the Poles of the World that the *Tropicks* have from the Equinoctial Circle, (*viz.* 23 degrees 30 minutes) and that the *Ecliptick* hath from the Poles of the World; and therefore run through the Poles of the *Ecliptick*.

## X *Of the* Images *called* Conſtellations, *drawn upon the Celeſtial Globe*.

Here I think fit to be beholding to Dr. *Hood*, for the paines he hath taken in his comment upon the *Images* and *Conſtelations*. He ſaith, The ſtars are brought into Conſtellations, for inſtructions ſake: things cannot be taught without names, to give a name to every ſtar had been troubleſome to the Maſter, and for the Scholler; for the Maſter to deviſe, and for the Scholler to remember: and therefore the Aſtronomers have reduced many ſtars into one Conſtellation, that thereby they may tell the better where to ſeek them; and being ſought, how to expreſs them.

All the Conſtellations formerly notified by the Antients were in number 48. twelve whereof we call the twelve Signes of the Zodiack, *viz.* 1 *Aries*, ♈. 2 *Taurus*, ♉. 3 *Gemini*, ♊. 4 *Cancer*, ♋. 5 *Leo*, ♌. 6 *Virgo*, ♍. 7 *Libra*, ♎. 8 *Scorpio*, ♏. 9 *Sagittarius*, ♐. 10 *Capricorn*, ♑. 11 *Aquarius*, ♒. 12 *Piſces*. ♓. One and twenty more are Placed in the North Hemiſphear, and are called 1 *Urſa minor*, 2 *Urſa Major*, 3 *Draco*, 4 *Cepheus*, 5 *Bootes*, 6 *Corona Septentri*, 7 *Hercules*, 8 *Lyra*, 9 *Cygnus*, 10 *Caſſiopeia*, 11 *Perſeus*, 12 *Auriga*, 13 *Serpentarius*, 14 *Serpens Ophiuchi*, 15 *Sagitta*, 16 *Aquila*, 17 *Delphinus*, 18 *Equiculus*, 19 *Pegaſus*, 20 *Andromeda*, 21 *Triangulum*. The other 15 are ſcituated in the South Hemiſphear, and called 1 *Cetus*, 2 *Orion*, 3 *Eridanus*, 4 *Lepus*, 5 *Canis Major*, 6 *Canicula*, 7 *Argo Navis*, 8 *Hydra*, 9 *Crater*, 10 *Corvus*, 11 *Centaurus*, 12 *Lupus*, 13 *Ara*, 14 *Corona Auſtrina*, 15 *Piſces Auſtrina*. Beſides there are 2 other Conſtellations in the North Hemiſphear, *viz.* *Antinous*,

and *Coma Berenices* : which because they were not specified by the Ancients are here inserted apart.

Now the Astronomers did bring them into these figures, and not into other, being moved thereto by these three reasons : first these Figures expreis some properties of the stars that are in them ; as those of the *Ram* to bee hot and dry ; *Andromeda* chained, betokeneth imprisonment : the head of *Medusa* cut off, signifieth the loss of that part: *Orion* with his terrible and threatning gesture, importeth tempest, and terrible effects: The *Serpent*, the *Scorpion*, and the *Dragon*, signifie poyson : The *Bull*, insinuateth a melancholy passion : The *Bear* inferreth cruelty, &c. Secondly, the stars, (if not precisely yet after a sort) do represent such a Figure, and therefore that Figure was assigned them: as for example, the *Crown*, both North, and South ; the *Scorpion* and the *Triangle*, represent the Figure which they have. The third cause, was the continuance of the memorie of some notable men, who either in regard of their singular paines taken in Astronomy, or in regard of some other notable deed, had well deserved of man-kind.

The first Author of every particular Constellation is uncertain ; yet are they of great antiquity; we receive them from *Ptolomie*, and he followed the *Platonicks*; so that their antiquity is great. Moreover we may perceive them to be ancient by the Sciptures; and by the Poets. In the 38 Chapter of *Job* there is mention made of the *Pleiades*, *Orion*, and *Arcturus*, and *Mazzaroth*, which some interpret the 12 Signes: *Job* lived in the time of *Abraham*, as *Syderocrates* maketh mention in his Book *de Commensurandis locorum distantiis*.

Now besides all this, touching the reason of the invention of these Constellations, the Poets had this purpose, *viz.* to make men fall in love with Astronomy: And to that intent have to every Costellation invented strange conceited stories, (as you may read at the latter end of this Book) therein imitating *Demosthenes*, who when he could not get the people of *Athens* to hear him in a matter of great moment, and profitable for the Commom-wealth, he began to tell them a tale of a fellow that sold an Ass ; by the which tale, he so brought on the Athenians, that they were both willing to hear his whole Oration, and to put in practice that whereto he exhorted them. The like intent had the Poets in of those Stories : They saw that Astronomy being for

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commodity singular in the life of man, was almost of all men utterly neglected: Hereupon they began to set forth that Art under Fictions; that thereby, such as could not be perswaded by commodity, might by the pleasure be induced to take a view of these matters: and thereby at length fall in love with them. For commonly you shall note this, that he that is ready to read the Stories, cannot content himself therewith, but desireth also to know the Constellation, or at leastwise some principal Star therein.

There are in Heaven yet twelve Constellations more, posited about the South Pole, which were added by *Frederico Houtmanno*, inhabiting on the Island *Sumatra* who being accommodated with the Instruments of that immortal *Tycho*, hath observed the Longitude and Latitude of those Stars, reduced them into Constellations, and named them as follows, 1 The *Crane*, 2 The *Phenix*, 3 The *Indian*, 4 The *Peacock*, 5 The *Bird of Paradice*, 6 The *Fly*. 7 The *Camelion*. 8 The *South Triangle*, 9 The *Flying Fish*, 10 *Dorado*, 11 The *Indian Fowl*, 12 The *Southern Serpent*.

## XI. *Of the Number of the Stars.*

Although in Heaven there be a very great number of visible Stars, which for their multitude seem innumerable; yet no wise man will from thence infer that they are impossible to be counted: for there is no Star in Heaven that may be seen, but its Longitude and Latitude may with meet Instruments for that purpose be exactly found; and being once found, it may have a name allotted it, which with its Longitude and Latitude may be Catalogized either for the memory of the Observer, or the knowledge of Posterity. Now therefore if any one Star may be observed, they may all be observed; and then may they all have Names given them; which tho to the ignorant it seem uncredible, yet to the sons of God, (as *Josephus* call Astronomers) who herein participate of their fathers knowledge, it is easie to *number the Stars, and call them all by their Names Psal.* 97, 4.

But tho all the Stars in Heaven may be numbred and named, yet have not the Ancient Astronomers thought fit to take notice of more then 1025 of the chiefest that are visible in our Horizon, they being sufficient for any purpose that we shall have occasion to apply them unto. Yet of late the industry of *Frederick Houtman*

*man* aforesaid, hath added to the Catalogue 136 Stars, with their Longitude Latitude and Magnitude, and given Names unto them: which upon my New Globes I have also ascerted, as may be seen about the South Pole thereof. So that with these 1025, observed by the Ancients, and these 136, the whole number of the Catalogue is 1161.

Some other Stars of late have been also observed by *Bairus*, among the several Constellations aforesaid; but none of any Considerable Magnitude, and therefore I think fit to pass them by, and come to their scituation in Heaven, according to Longitude and Latitude.

## XII. *Of the Scituation of the* Stars.

Longitude of the Stars

The Stars are Scituate in Heaven according to their Longitude and Latitude As the Longitude of any Place upon the Terrestrial Globe is an Arch of the Equator, Comprehended between the first Meridian and the Place. So the Longitude of any Star upon the Celestial Globe is an Arch of the Ecliptick, contained between the first point of ♈ and the Star inquired after. But yet because the Ecliptick is divided into twelve Signes, the Longitude of a Star is therefore (in the most Customary account) an Arch of the Ecliptick comprehended between the Semi-circle of Longitude passing through the beginning of the Signe the Star is in, and the Semi-circle of Longitude passing through the Center of the Star.

Latitude of the Stars

The Latitude of a Star is either North or South: North, if on the North side of the Ecliptick; South, if on the South side of the Ecliptick. As the Latitude of any Place upon the Terrestrial Globe is an Arch of the Meridian, contained between the Equator and the Parallel of the Place, So is the Latitude of any Star upon the Celestial Globe an Arch of a Semi-circle of Longitude, comprehended between the Equinoctial and the Star inquired after.

## XIII. *Of the* Magni tudes *of the* Stars:

For the better distinction of the several sizes of Stars, they are divided into six several Magnitudes. The biggest and brightest Stars are called Stars of the first Magnitude; Those one degree inferiour

inferiour in light and bigneſs are called Stars of the Second Magnitude, Thoſe again one degree inferiour to the Stars of the ſecond Magnitude, are called Stars of the Third Magnitude, and ſo the Stars gradually decreaſe unto the ſixth Magnitude, which is the ſmalleſt, ſome few obſcure Stars only excepted, which for their Minority and dimneſs are called *Nebulæ*. Theſe ſeveral Magnitudes of the ſtars are expreſſed on the Globe in ſeveral ſhapes, as may be ſeen in a ſmall Table placed on the Globe for that purpoſe.

Now for your further ſatisfaction and delight, I have inſerted a Collection of D. *Hoods*, wherein is expreſſed the meaſure of every Magnitude, and the proportion it hath, firſt, to the Diameter, and ſecondly, to the Body of the Earth. The meaſures of the ſeveral Stars

The greatneſs of any thing (ſaith he) cannot be better expreſſed then by comparing it to ſome common meaſure, whoſe quantity is known: The common meaſure whereby Aſtronomers expreſs the greatneſs of the Stars, is the Earth;

Sometimes they compare them with the Diameter of the Earth, ſometimes with the Globe thereof: The Diameter according to their account which allow but 60 miles to a degree, containeth 6822 $\frac{8}{11}$ miles; and the whole ſoliditie of the Globe containes 165, 042, 481, 283. miles and $\frac{79}{197}$. According to Ptolome, who allotteth to every degree 62 $\frac{1}{2}$ miles, the Diameter containeth 7159 miles $\frac{1}{11}$, and the whole ſoliditie of the Globe, hath 192, 197, 184, 917, $\frac{473}{1331}$ miles.

## *The proportion of the Diameters of the fixed Stars; Compared with the Diameter of the Earth.*

The Diameter of a fixed Star of the firſt Magnitude compared with the Diameter of the Earth hath ſuch proportion to it, as 19 hath to 4: therefore it containeth the Diameter of the Earth 4 times and $\frac{3}{4}$.

The Diameter of a Star of the ſecond Magnitude is unto the Diameter of the Earth as 269 is to 60: therefore it containeth it 4 $\frac{29}{60}$ times.

The Diameter of a fixed Star of the third Magnitude is unto the Diameter of the Earth as 25 unto 6: therefore it containeth it 4 $\frac{1}{6}$ times.

The Diameter of a fixed Star of the fourth Magnitude is unto

the Diameter of the Earth as 19 unto 5 : therefore it containeth it $3\frac{4}{5}$ times.

The Diam. of a fixed Star of the fifth Mag. is unto the Diameter of the Earth, as 119 unto 36, therefore it containeth it $3\frac{11}{36}$ times.

The Diam. of a fixed Star of the sixth Mag. is unto the Diame. of the Earth, as 21 unto 8 ; therefore it containeth it $\frac{5}{8}$ times.

As for the proportions of the cloudie and obscure Stars, they are not expressed because they are but few, and of no great account in respect of their smalness.

## *The proportions of the fixed Stars compared with the Globe of the Earth, are as follow.*

A Star of the first Magnitude is to the Globe of the Earth, as 6859 to 64. therefore it containeth the Globe of the Earth 107 $\frac{1}{8}$ times.

A Star of the second Magnitude is to the Globe of the Earth, as 19465109 is to 216000. therefore it containeth it 90 $\frac{1}{8}$ times.

A Star of the third Magnitude is to the Globe of the Earth, as 15625 is unto 216 : therefore it containeth it 72 $\frac{1}{8}$ times.

A Star of the fourth Magnitude is to the Globe of the Earth as 6850 is unto 125 : therefore it containeth the Globe of the Earth $54\frac{11}{12}$ times.

A Star of the fifth Magnitude is to the Globe of the Earth, as 1685159 : is unto 46656 : therefore it containeth the Globe of the Earth $36\frac{1}{8}$ times.

A Star of the sixth Magnitude is to the Globe of the Earth, as 9261 is unto 512: therefore it containeth the Globe of the Earth $18\frac{1}{10}$ times.

I confess all this may seem matter of incredulity to those whose understanding is swayed by their visual sence; but if they be capable to consider the vast distance of those Huge Bodies, (the Stars) from the face of the Earth, and also the diminutive quality of Distance, their reason will be rectified, and their incredulity turn'd into an acknowledgement of the unspeakable wisdom of Almighty God; and they will say with the *Psalmist, Great is our Lord, Great is his Power, his Wisdom is infinite. Psal.* 147. 5.

The distance of the Stars therefore from the Earth, is according to M. *John Dee's* Computation, 20081 $\frac{1}{2}$ Semidiameters of the Earth. The Semidiameter of the Earth containeth of our com-

common miles 3436 $\frac{4}{11}$. Such miles as the whole Earth and Sea round about is 21600: allowing for every degree of the greatest Circle 60 miles: so that the distance of the Stars from the Earth, is in miles 69006540. Now as M. *Dee* saith, (almost in these same words) if you weigh well with your self this little parcel of fruit Astronomical; as concerning the bigness and distance of the Stars, &c. and the Huge massiness of the Starry Heaven, you will find your Consciences moved with the Kingly Prophet to sing the confession of Gods Glory; and say, *The Heavens Declare the Glory of God, and the firmament sheweth forth the works of his Hands.*

## XIIII. *Of the* Nature *of the* Stars.

To many of the Principal Stars there is in Planetical Characters prefixed their Planetical Natures. The Astrologers make great use of them for knowing the nature of the Stars: for those Stars that have the character of ♄ adjoined are said to be of the nature of ♄: those that have ♃ adjoined, are of the nature of ♃: and so of the rest. If a Star have the characters of two Planets adjoined, that Star participates of both their Natures, but most of that Planets whose character is first placed.

The use Astronomers make of those characters, is for knowing that culler of any Star; as if a Star have ♄ adjoined, it is of the culler of ♄; if ♃, it is the culler of ♃, &c.

The fixed Stars are known from the Planets by their continual twinckling; for the Planets never twinckle, but the fixed Stars do.

## XV. *Of Via Lactea, or the* Milky way.

This subject because it is already so fully handled by Dr. *Hood*, that more then he hath written cannot well be said, either of his own oppinion or other mens, I think fit therefore to give you his own words: which are as follow.

VIA LACTEA. or *Circulus Lacteus*; by the Latines so called; and by the Greekes, *Galaxia*; and by the English, the *Milky way*. It is a broad white Circle that is seen in the Heaven. In the North Hemisphear, it beginneth at *Cancer*, on each side the head thereof, and passeth by *Auriga*, by *Perseus*, and

and *Caſſiopeia*, the *Swan*, and the head of *Capricorn*, the tayl of *Scorpio*, and the feet of *Centaur*, *Argo* the *Ship*, and ſo unto the head of *Cancer*. Some in a ſporting manner, do call it *Watling ſtreet*; but why they call it ſo, I cannot tell; except it be in regard of the narrowneſs that it ſeemeth to have, or elſe in reſpect of that great High way that lieth between *Dover* and S. *Albons*, which is called by our men *Watling ſtreet*.

Concerning this Circle there are ſundry opinions: for there is great difference among ſome writers, both touching the place, matter, and efficient cauſe thereof. *Ariſtotle* diſſenteth from all other, both Philoſophers and Poets, in the place, matter, and cauſe of this Circle; ſaying, that it is a Meteor ingendred in the Air, made of the vapors of the earth, drawn up thither by the heat of the Sun, and there ſet on fire. But his opinion is of all men confuted.

Firſt, touching the place, it cannot be in the Air; for whatſoever is in the Air, is not ſeen of all men, at all times, to be under one and the ſame part of Heaven. If we ſee it in the South, they that are in the Weſt ſhall ſee it under the Eaſt ſide of the Heaven; and they that are in the Eaſt, ſhall ſee it in the Weſt part of the Heaven; but this Circle is of all men ſeen alwaies under the ſame part of Heaven, and to be joyned with the ſame Stars; therefore it cannot be in the Air.

Again, for the matter, it cannot be made of that which *Ariſtotle* nameth (*i. e.*) the vapours of the earth, becauſe of the long continuance of the thing, and that without any alteration: for it is impoſſible that any Meteor made of vapours drawn up from the water, or exhalations from the earth, ſhould laſt ſo long; as may be ſeen in blazing Stars; which though they have continued long, as namely, 16. moneths, ſome more, ſome leſs; yet at the length they have vaniſhed away: whereas this Circle hath continued from the beginning unto this day. Beſides, put caſe it were made of theſe exhalations, Whence will they infer the uniformity thereof? The Comets do alter diverſly, both in the faſhion of their blazing, and alſo in their ſeveral quantities; whereas in this Circle, there is nothing but the ſame part, alwaies of one form and of one bigneſs. In the efficient cauſe therefore he muſt needs err: for if it be neither in the Air, nor made of the exhalations of the earth, it cannot be cauſed by the Sun; for the

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one is the place, and the other the matter, wherein, and whereupon the Sun sheweth his power.

All other, (besides *Aristotle*) agree in the place, but differ in the efficient cause thereof: and they are either Philosophers, or Poets. Both these affirm that it is in the Firmament (*i. e.*) in the eight Sphear; but they disagree in the cause thereof.

The Philosophers (and chiefely *Democritus*) affirm the cause of the thing, to be the exceeding great number of Stars in that part of Heaven, whose beams meeting together so confusedly, and not coming distinctly to the ey, causeth us to imagine such a whiteness as is seen. But the best opinion is this, that this *Milky way* is a part of the Firmament, neither so thin as the other parts thereof are, nor yet so thick as the Stars themselves. If it were as thin as the other parts of the Heaven besides the Stars, then could it not retain the light, but the light would pass through it, and not be seen: If it were as thick as the Stars, then would the light be so doubled in it, that it would glister and shine, as the Stars themselves do: but being neither so thin as the one, nor so thick as the other, it becommeth of that whiteness we see.

*Blaeu* saith, This *Lactean* whiteness and clearness ariseth from a great number of little Stars, constipated in that part of Heaven; flying so swiftly from the sight of our eyes, that we can perceive nothing but a confused light: this the *Tubus Dioptricus* (more lately found out) doth evidently demonstrate to us: by the benefit of which little Stars (otherwise inconspicuous to our eyes) are there clearly discerned.

About the Southern Pole are seen two white spots, like little clouds, colured like the *via Lactea*. One of which is trebble the Latitude of the other; some Mariners call them *Nubeculæ Magellani*.

This *Milkie way* is discribed on the Globe between two tracks of smal Pricks, running through the Images mentioned in the beginning of this Section.

Thus have you the definition of the Globes; with the description of all the lines, Circles, &c. described thereon. I shall now explain unto you the meaning of Several words of Art, which in the use of them you will meet with, and then come to the Use it self.

And first, what is meant by the word *Horizon*.

When I spake of the *Horizon* before, I only mentioned the wooden *Horizon* or frame about the Globe; which because it represents the *Mathematical Horizon*, is therefore called the *Horizon*: but the word *Horizon* is to be considered more particularly, two manner of waies: as

First, the *Natural Horizon*.

Secondly, the *Mathematical Horizon*.

The *Natural Horizon* is that Appearent Circle which divides the Visible part of Heaven from the invisible; it extends it self in a straight line from the Superficies of the Earth, every way round about the place you stand upon, even into the very Circumference of the Heavens. It is onley discerned at Sea, or on plaine ground, that is free from all hinderances of the sight as Hills, Trees, Houses, &c.

The *Mathematical Horizon* (which indeed is meant in this Treatise, so oft as I shall have occasion to name the word *Horizon*) is a great Circle which divides that part of Heaven which is above us, from that which is under us, precisely into two equal parts: whose *Poles* are the *Zenith* and *Nadir*. In this Circle the *Azimuths* or *Verticle Circles* are numbred: and by this Circle our Daies and Nights are measured out unto us: for while the Sun is above the *Horizon* it is day; and when it is under the *Horizon* it is Night.

This Circle is represented unto us by the upper Plain of the wooden *Horizon*: Therefore so oft as you are directed to bring any degree or Star &c. to the *Horizon*, it must be understood that you must turn the Globe till the degree or Star come just to the upper inner edge of the wooden *Horizon*.

The *Zenith*, and *Nadir*, are two points opposite to one another,

*Zenith.* The *Zenith* is that point in Heaven which is directly over our Heads: and the *Nadir* is that point in Heaven which is directly under our feet.

*Nadir.*

*Azimuths*, or *Verticle Circles.* The *Azimuths* or *Verticle Circles* are great Circles passing through the *Zenith*, and *Nadir*, whose *Poles* are the *Zenith* and *Nadir*. And as the *Meridians* cut the *Equator*, and all *Parallels* to the *Equator* at Right Angles, so the *Azimuths* cut the *Horizon* and all *Almicanthars* at Right Angles also. The *Azimuths* (as the *Meridians*) are infinite; and are numbred by degrees from the East and West point towards the North and South in the Horizon: as also is the *Amplitude*.

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The *Almicanthars* are Circles Parallel to the Horizon, whoſe Poles are the *Zenith* and *Nadir*. They are alſo called *Circles of Altitude*, becauſe when the Sun Moon or any Star, is in any number of degrees above the *Horizon*, it is ſaid to have ſo many degrees of *Altitude*, which degrees of *Altitude* are numbred upon the *Verticle Circle* from the *Horizon* upwards, towards the *Zenith*. The *Almicanthars* are alſo infinite: as *Parallels*, *Meridians* and *Azimuths* are. *Almicanthars*, or *Circles of Altitude*.

The *Amplitude* is the number of degrees contained between the true Eaſt or Weſt point in the *Horizon*, and the riſing or ſetting of the Sun, Moon, or Stars. &c. *Amplitude*.

The *Declination* is the number of degrees that the Sun, Moon, or any Star, is diſtant from the *Equinoctial*, towards either *Pole*: and hath a double Denomination, *viz. North Declination*, and *South Declination*: for if the Sun Moon or Star ſwarve towards the North *Pole*, they are ſaid to have *North Declination*; if towards the South Pole, *South Declination*. *Declination*.

The *Right Aſcenſion* is the number of degrees of the *Equinoctial* (accounted from the firſt point of *Aries*) which comes to the *Meridian* with the Sun Moon or Star, or any other point in *Heaven* propoſed. *Right Aſcenſion*.

The *Oblique Aſcenſion* is the number of degrees of the *Equinoctial* which comes to the Eaſt ſide of the *Horizon* with the Sun Moon or any Star. *Oblique Aſcenſion*.

The *Oblique Deſcenſion* is the degrees of the *Equinoctial* which comes to the Weſt ſide of the *Horizon* with the Sun Moon or any Star. *Oblique Deſcenſion*.

The *Aſcenſional Difference* is the number of degrees after ſubtraction of the *Oblique Aſcenſion* from the *Right Aſcenſion*, or the *Oblique Deſcenſion* from the *Oblique Aſcenſion*. *Aſcenſional Difference*.

So many degrees as you are ſaid to ſail towards the *Pole*, you are ſaid to *Raiſe the Pole*; and ſo many degrees as you ſail from the *Pole*, you are ſaid to *Depreſs the Pole*. *Raiſe the Pole*. *Depreſs the Pole*.

*Courſe*, is the point of the Compaſs you ſail upon; as if you ſail *Eaſt-wards*, it is an *Eaſterly Courſe*, if *Weſt*, a *Weſterly Courſe* &c. *Courſe*.

*Diſtance* is the number of leagues you have ſailed from any Place, upon any *Courſe*. *Diſtance*.

A *Zone* is a ſpace of Earth contained between two Parrallels. The ancient *Geographers* made five *Zones* in the *Earth*. Two *Frozen*, Two *Temperate*, and one *Burnt Zone*. *Zone*.

*Frozen Zones.* The two *Frozen Zones* are those parts of the *Globe*, comprehended between the North Pole and the *Arctick Circle*, and the South Pole and the *Antarctick Circle*; by the Ancients called inhabitable; because the Sun being alwaies far remote from them, shoots its beams *Obliquely* upon them, which *Oblique* beams are so very weak, that all their Summer is but a continued Winter, and the Winter (as they thought) impossible to be at all indured.

*Temperate Zones.* The *Temperate Zones* are the space of *Earth* contained between the *Arctick Circle* and the *Tropick* of ♋, and the *Antarctick Circle* and the *Tropick* of ♑: by the Ancients called *Temperate* and Habitable; because they are composed of a sweet Mediocrity, between outragious Heat and extremity of Cold.

*Burnt Zone.* The *Burnt Zone* is the space of *Earth* contained between the *Tropick* of ♋, and the *Tropick* of ♑, called by the Ancients *Unhabitable*; because in regard the Sun never moves out of this *Zone* but darts its Beames perpendicularly upon it, they imagined the *Air* was so unsufferable *Hot*, that it was impossible for any to inhabite in this *Zone*. So that as you see they held the two *Temperate Zones* only habitable; and the two *Frozen Zones* and one *Burnt Zone*, altogether unpossible to be inhabited. But their Successors either animated by industry, or compeld by necessity, have apparently confuted that Assertion; for at this time many thousands can witness that their bloods are not so greasie as to be melted in the Scortching heat of the one, or so watry as to be congealed in the Icy frosts of the other.

*Climates.* The Ancients have yet otherwise divided the *Earth* into four and twenty *Northern Climates*, and four and twenty *Southern Climates*: so that in all there is eight and forty *Climates*. The *Climates* are altered according to the half hourly increasing of the longest daies; for in the Latitude where the longest daies are increased half an hour longer then they are at the Equator (*viz.* longer then 12 hours) the first *Climate* begins; and in the Latitude where they are increased an whole hour longer then in the Equator, the second *Climate* begins; where the daies are increased three half hours longer then in the Equator, the third *Climate* begins; and so onwards, the *Climates* alter according as the longest day increases half an hour, till you come to find the longest day 24 hours long

Now the Ancients (in those times) knowing no more then nine Habitable *Climates*, gave names only to nine. The first they

they called *Dia Meroes*, after the name of a famous *Inland Iland*, which is scituate about the middle of that *Climate*, and is now called *Gueguere*. The second *Climate* they called *Dia Syenes*, after the name of an eminent *Citty in Egypt*, lying about the midst of that *Climate*. The third *Dia Alexanderas*, after the name of the *Metropolitan Citty* of *Egypt*. The fourth *Dia Rhodes*. The fifth *Dia Romes*. The sixth *Dia Ponton*. The seventh *Dia Boristheneos*, The eighth *Dia Ripheos*. The ninth *Dia Daniam*.

These names belong only to the *Climates* on the North side of the Equator. But those on the South side (in regard of the smal Discoveries those Ages had on that side the Equator) were distinguisht only by the addition of the word *Anti*, to the same *Southerly Climate*: as the first *Southern Climate* (which is that *Climate* that lies as many degrees to the South-ward as the first doth to the North-ward) they called *Anti Meroes*. The second *Anti Syenes*. The third *Anti Alexanderas*: and so on to the ninth.

In every *Climate* is included two Parallels, which are of the same nature with the *Climates*, save only that as the *Climates* alter by the half hourly increasing of the longest day, the *Parallels* alter by the quarter hourly increasing of the longest day. *Parallels.*

Furthermore, in respect of the *Horizon*, we find the *Sphear* constituted into a threefold Position: as first, into a *Direct Sphear*, Secondly, a *Parallel Sphear*, Thirdly, an *Oblique Sphear*.

A *Direct Sphear* hath both the Poles of the World in the *Horizon*, and the *Equinoctial* transiting the *Zenith*. In a *Direct Sphear* all the *Circles Parallel* to the Equator make right angles with the *Horizon*, and are also divided into two equal parts by the *Horizon*: and in a *Direct Sphear* the Sun Moon and Stars are alwaies twelve hours above the *Horizon*, and twelve hours under the *Horizon*, and consequently make twelve hours *Day*, and twelve hours *Night*. *Direct Sphear.*

It is called a *Direct Sphear* becaus all the *Celestial Bodies*, as Sun Moon and Stars &c. by the *Diurnal Motion* of the *Primum Mobile*, ascend directly above, and descend directly below the *Horizon*.

They that inhabite under the Equator have the *Sphear* thus posited; as in the *Iland Borneo, Sumatra, Celebes*, St. *Thomas*, a great part of *Africk*, *Pern* in the *West-Indies*: &c. as you may

ſee by the *Globe* it ſelf; if you move the *Braſen Meridian* through the notch in the *Horizon*, till the Poles thereof touch the *Horizon*. As in this Figure.

*Parallel Sphear.*

A *Parallel Sphear* hath one Pole of the VVorld in the *Zenith*, the other in the *Nadir*, and the *Equinoctial* line in the *Horizon*.

In a *Parallel Sphear* all the *Circles Parallel* to the *Equinoctial* are alſo *Parallel* to the *Horizon*, and in a *Parallel Sphear* from the 10th of *March* to the 11th of *September* (the Sun being then in the *Northerly Signes* and conſequently on the North ſide the *Horizon*) there is ſix Moneths Day in the North, and ſix Moneths Night in the South: and contrarily from the 11th of *September* to the 10th of *March*, (the Sun being then in the *Southerly Signes*, and therefore on the South ſide the *Horizon*) there

there is six Moneths Day in the South, and six Moneths Night in the North.

It is called a *Parallel Sphear*, becauſe the Sun Moon or Stars in a *Diurnal Revolution* of the *Heavens*, neither aſcend higher or deſcend lower, but alwaies move *Parallel* to the *Horizon*.

The *Earth* is thus Poſited under both the Poles, *viz.* in 90 degrees of Latitude; as may be ſeen by the *Globe*, if you turn the *Braſen Meridian* till either of the Poles be elevated 90 degrees above the *Horizon*. As in this figure.

An *Oblique Sphear* hath the *Axis* of the *World* neither *Direct* nor *Parallel* to the *Horizon*, but lies aſlope from it. *Oblique Sphear.*

In an *Oblique Sphear* all the *Celeſtial Bodies*, as Sun Moon or Stars &c. have (in reſpect of the *Horizon*) Oblique and unequal Aſcenſions and Deſcenſions, and all the lines Parallel to the Equator

Equator make unequal Angles with the *Horizon*, and are cut by the *Horizon* into unequal parts; for those lines towards the elevated Pole, have a greater portion of a Circle under the *Horizon* then above it: only the Equator because it hath the same Center with the *Horizon*, doth divide the *Horizon* into two equal parts, and is also divided into two equal parts by the *Horizon*.

Hence is follows that when the Sun is in any part of the *Ecliptick* that declines towards the elevated Pole, the Daies in the elevated *Hemisphear* shall be longer then the Nights: and when the Sun is in any part of the *Ecliptick* that declines towards the Depressed Pole, the Nights shall be longer then the Daies. But when the Sun is in the *Equinoctial*, (because whether the Pole be either Raised or Depressed) equal portions remain both above and under the *Horizon*, therefore the Daies are of the same length with the Nights, and the Nights with the Daies.

Also in an *Oblique Sphear*, all those Stars that have as great or greater number of degrees of Declination then is the elevated Poles Complement of Latitude to 90, never set or come under the *Horizon*, and those Stars that have the same Declination about the Depressed Pole never rise.

It is called an *Oblique Sphear*, because all the Circles of the *Sphear* move *Obliquely* about the *Horizon*.

The *Earth* is thus *Obliquely* posited to all those *Nations* that inhabite under any degree of Latitude either North or Southwards between the Equator and either Pole: as may variously be seen by the Globe, when the Axis lies not on the *Horizon*, nor the Equator is Parallel to the *Horizon*. As in this following Figure,

Moreover all Places have their *Antipodes*, *Peraci* and *Antaci*.

The *Antipodes* of any Place is the oppoſite degree on the *Globe*. As if a Perpendicular were let fall from the Place you ſtand on, through the Center of the Earth, and continued till it paſs quite through the Superficies of the *Earth*, on the other ſide; then in the point where the Perpendicular cuts the Superficies of the Earth on the other ſide, is the *Antipodes* of that Place. *Antipodes.*

The Inhabitants of any two Places that are in *Antipodes* to each other, go with their Feet directly againſt one another: and have a contrariety in the Seaſons of the Year, and Riſings, and Settings, of the Sun Moon Stars, and all other of the *Heavenly Bodies:* ſo that when with us it is Spring, with them it is Autumn; when with us the Sun Riſes, in our *Antipodes* it Sets; and therefore their Morning is our Evening, their Noon our Mid-

night, their Evening our Morning; and their Longeſt Day our ſhorteſt.

*Periæci.* The *Periæci* of any Place is that point in the ſame Parallel which comes to the Meridian with the *Antipodes*.

In the *Periæci* of any Place, there happens not that Contrariety of Seaſons in the Year, that doth in the *Antipodes*; nor in the Length of Daies: for the Daies in both Places are of equal length: but in the times of the Day, there is the ſame contrariety, for (though their Spring be our Spring, and thereſt of their Seaſons of the year the ſame with ours, yet) their Morning is our Evening, their Night our Day, &c.

*Antæci.* The *Antæci* of any Place is the point under the ſame Meridian that is diſtant from the Equator on the South ſide ſo many degrees as your Place is diſtant from the Equator on the North ſide.

In the *Antæci* there happens not that contrariety in the Daies as doth in the *Antipodes*, but in the Seaſons of the Year there is the ſame contrariety; for in our *Antæci* their Morning is our Morning, their Noon our Noon, their Night our Night: but herein is the Difference, their Spring is our Fall, their Summer our VVinter, &c. and their Longeſt Day our ſhorteſt: as in the *Antipodes*.

# The Second BOOK.

## Shewing the Practical Uſe of the

# GLOBES.

*Applying them to the Solution of* Aſtronomical *and* Geographical *Problemes.*

## *PRÆFACE.*

### Some Advertiſements in Chooſing and Uſing the GLOBES.

1.

*SEE the Papers be well and neatly paſted on the Globes: which you may know, if the Lines and Circles deſcribed thereon meet exactly, and continue all the way even and whole: the lines not ſwerving out or in, and the Circles not breaking into ſeveral Arches; nor the Papers either come ſhort, or lap over one the other.*

2. *See that the Culler be tranſparent, and ly not too thick on the Globe; leſt it hide the ſuperficial Deſcriptions.*

3. *See the Globe hang evenly between the Meridian and Horizon, not inclining more to one ſide then the other.*

4. *See the Globe ſwim as cloſe to the Meridian and Ho-*

*rizon as conveniently it may; lest you be too much puzzeld to find against what point of the Globe any degree of the Horizon or Meridian is.*

5. *See the Equinoctal line be one with the Horizon, when the Globe is set in a* Parallel Sphear.

6. *See the Equinoctal line cut the East and West point of the Horizon, when the Globe is set to an* Oblique Sphear.

7. *See the Degrees marked with* 90. *and* 00, *hang exactly over the Equinoctial line of the Globe.*

8. *See that exactly half the Meridian be above the Horizon, and half under the Horizon: which you may know if you bring any of the Decimal Divisions to the North Side of the Horizon, and find their Complement to* 90. *in the South.*

9. *See that when the Quadrant of Altitude is placed at the Zenith, the Beginning of the Graduations reach just to the superficies of the Horizon.*

10. *See that while the Index of the Hour Circle (by the motion of the Globe) passes from one hour to the other,* 15. *degrees of the Equator pass through the Meridian.*

11. *If you have a Circle of Position, see the Graduations agree with those of the Horizon.*

12. *See that your wooden Horizons be made substantial and strong; for (besides the Inconveniences that thin wood is subject unto, in respect of warping and shrinking) I have had few Globes come to mending that have not had either broken Horizons, or some other notorious fault, occasioned through the sleightness of the Horizons.*

## In the Using the Globes.

KEep the East side of the Horizon alwaies towards you, unless your Proposition requires the turning of it: which East side you may know by the Word East, *placed on the outmost verge thereof.* For then have you the gradu-

ated

*ated ſide of the Meridian alwaies towards you ; the Quadrant of altitude before you , and the Globe divided exactly into two equal parts.*

*So oft as I name* to, at, of, *or* under the Meridian , *or* Horizon, *I mean the Eaſt ſide of the Meridian, and Superficies of the Horizon : becauſe the Eaſt ſide of the Meridian paſſes through the North and South points ,both of the Globe and Horizon; and agrees juſt with the middle of the Axis : And the Superficies of the Horizon divideth the Globe exactly into two equal parts.*

*It you happen to uſe the Globes on the South ſide the Equator , you muſt draw the wyers out of either Pole , and change them to the contrary Poles ; putting the longeſt wyer into the South Pole. And becauſe on the other ſide the Equator the South Pole is elevated , therefore you muſt elevate the South Pole of the Globe above the Horizon ; according to the South Latitude of your Place ; as ſhall be ſhewed hereafter.*

*In the working ſome Problemes it will be required that you turn the Globe to look on the Weſt ſide thereof : which turning will be apt to jog the Ball, ſo as the degree that was at the Horizon or Meridian, will be moved away, and thereby the Poſition of the Globe altered. To avoid which inconvenince you may make uſe of a Quill, thruſting the Feather end between the Ball and the Brazen Meridian, and ſo wedge it up , without wronging the Globe at all , till your Propoſition be anſwered.*

## Probleme I.

### *To find the* Longitude *and* Latitude *of Places, on the* Terreſtrial Globe.

SEek the Place on the Terreſtrial Globe, whoſe Longitude and Latitude you would know, and bring that Place to the

Brazen Meridian; and see how many degrees of the Equator is cut by the Meridian, from the first general Meridian, (which on my Globes pass through *Gratiosa*, one of the Isles of the *Azores*,) for that number of degrees is the Longitude of the Place.

### Example.

I desire to know the Longitude of *London*, and close to the name *London* I find a smal mark o thus, (which smal mark is in some Globes and Maps adorned with the Picture of a Steeple, &c.) therefore I do not bring the word *London* to the Meridian, but that smal mark; for that alwaies represents the the Town or Citty sought for: And keeping the Globe steddy in this Position, I examine how many degrees of the Equator are contained between the Brazen Meridian, and the first general Meridian; which I find to be 24. deg. 00. min. Therefore I say the Longitude of *London* is 24. degrees 00. min.

### For the Latitude.

See on the Brazen Meridian how many degrees are contained between the Equator and the mark for *London*; which in this Example is $51\frac{1}{2}$: therefore I say *London* hath $51\frac{1}{2}$ degrees North Latitude.

## Probleme II.

### *The* Longitude *and* Latitude *being known, to Rectifie the Globe fit for use.*

1. When you rectifie the Globe to any particular Latitude, you must move the Brazen Meridian through the notches of the Horizon, till the same number of degrees accounted on the Meridian from the Pole (about which the Hour-Circle is) towards the North point in the Horizon (if in North Latitude, and toward the South if in South Latitude) come just to the edge of the Horizon.

### Example.

By the former Proposition I found the Latitude of *London* to be $51\frac{1}{2}$ de-

$51\frac{1}{2}$ degrees North Latitude: therefore I count $51\frac{1}{2}$ degrees from the Pole downwards towards my right hand, and turn the Meridian through the notches of the Horizon till those $51\frac{1}{2}$ degrees comes exactly to the uppermoſt edge of the North point in the Horizon; and then is the Meridian rectified to the Latitude of *London*.

2. Next rectifie the Quadrant of altitude, after this manner, Screw the edge of the Nut that is even with the graduated edge of the thin Plate, to $51\frac{1}{2}$ degrees of the Brazen Meridian, accounted from the Equinoctial on the Southern ſide the Horizon, which is juſt the *Zenith* of *London*: and then is your Quadrant Rectified.

3. Bring the degree of the Ecliptick the Sun is in that day, to the Meridian: which you ſhall learn to know by the next Probleme, and then turn the Index of the Hour Circle to the hour 12. on the South ſide the Hour Circle, and then is your Hour Circle alſo rectified fit to uſe, for that Day.

4. Laſtly, If you will rectifie the Globe to correſpond in all reſpects with the Poſition and Scituation of the Sphear, you muſt ſet the four Quarters of the Horizon, viz. *Eaſt*, *Weſt*, *North*, and *South*, agreeable with the four quarters of the World; which you may do by the Needle in the bottom of the Horizon; for you muſt turn the Globe ſo long till the Needle point juſt to the Flower de luce. Next you muſt ſet the Plain of the wooden Horizon parallel to the Horizon of the World; which you may try by ſetting a common Level on the four Quaters of the Horizon. And then poſiting the degree of the Ecliptick the Sun is in, to the Height above, or depth below the Horizon, the Sun hath in Heaven, (as by the 11th Probleme) your Globe is made Correſpondent in all points with the frame of the Sphear, for that particular Time, and Latitude.

## PROBLEME III.

### *To find the Place of the Sun in the Ecliptick, the Day of the Moneth being firſt known.*

SEek the Day of the Moneth in the Circle of Moneths upon the Horizon, and right againſt it in the Circle of Signes is the degree of the Ecliptick the Sun is in.

Exam.

## Example.

Imagine the Day to be given is *May* 10. therefore I ſeek on the Horizon in the Circle of Moneths, for *May*, and find the Moneths divided into ſo many parts as there is Daies in the Moneth; which parts are marked with Arithmetical figures, from the beginning of the Moneth to the end, and denote the number of the Day of the Moneth that each Diviſion repreſents: therefore among the Diviſions I ſeek for 10, and directly againſt it in the Circle of Signes, I find ♉ 29. degrees. Therefore I ſay *May* 10. the Suns Place is in 29. degrees of ♉.

But note, that if it be *Leap Year*, inſtead of the 10. of *May* you muſt take the 11. of *May*: becauſe *February* having in a *Leap Year* 29. Daies, the 29. of *February* muſt be reckoned for the firſt of *March*, and the firſt of *March* for the ſecond of *March*; the ſecond of *March* for the third of *March*; and ſo throughout the year.

The *Leap Year* is cauſed by the ſix od hours more then 365. daies that are aſſigned to every common Year: ſo that in a Revolution of 4. Years, one Day is gained, which is added to *February*; and therefore *February* hath every fourth or *Leap Year* 29. Daies.

## Probleme IIII.

### *To find the Day of the Moneth, the Place of the Sun being given.*

AS in the laſt Probleme it was your task to find on the Horizon the Day of the Moneth firſt, ſo now you muſt firſt ſeek the Signe and degree the Sun is in, and againſt it in the Circle of Moneths you ſhall ſee the Day of the Moneth: As againſt ♉ 29. you have *May* 10.

## Probleme V.

### *The Place of the Sun given, to find its Declination.*

HAving by the third Probleme found the Suns Place on the Plain of the Horizon, you muſt ſeek the ſame degree in the

the *Ecliptick*, on the Globe; then bring that degree to the Brazen Meridian; and the number of degrees intercepted between the Equinoctial and the degree just over the degree of the Ecliptick the Sun is in, is the Declination of the Sun for that Day: and bears its Denomination of North or *South*, according to its Position either on the North or South side the Equinoctial.

## Example.

By the third Probleme aforesaid, of *May* 10. I find ♉ 29. the *Suns* Place; Therefore I seek in the *Ecliptick* Line on the Globe for ♉ 29. and bring it to the East side of the Brazen Meridian, which is the graduated side; and over ♉ 29. I find on the Brazen Meridian 20. deg. 5. min. (numbred from the Equinoctial:) and because ♉ is on the North side the Equinoctial, therefore I say, The Sun hath *May* 10. North Declination 20. degrees 5. min.

## Probleme VI.

### *The Place of the Sun given, to find its Meridian Altitude.*

THe Globe rectified, Bring the degree of the Sun to the Meridian, (or which is all one, the degree of the *Ecliptick* the Sun *is* in;) and the number of degrees contained between the Horizon and the Suns Place in the Meridian, is the number of degrees that the *Sun* is Elevated above the Horizon at Noon, or (which is all one) the Meridian Altitude of the *Sun*.

## Example.

To know what Meridian Altitude the Sun hath here at *London*, *May* 10. I bring the Suns Place (found by the third Probleme) to the Meridian, and count on the Meridian the number of degrees contained between the Horizon and the degree just over the *Suns* Place; which in this Example I find to be $58\frac{1}{2}$. Therefore I say the *Suns* Meridian Altitude *May* 10. is here at *London* $58\frac{1}{2}$ degrees.

## Probl. VII.

*The Suns Place given, to find the Hour of Sun Rising, and the length of the Night and Day.*

The Globe and Hour Index rectified, Seek the degree the Sun is in on the Globe, and bring that degree to the Eastern Side of the Horizon; and the Index of the Hour Circle will point at the Hour of Sun Rising.

### Example.

To know the Hour of Sun Rising here at *London*, *May* 10. The Suns Place (as before) is ♉ 29. Therefore the Globe being rectified (as before) I seek ♉ 29. degrees on the Globe, and bring that degree to the East Side of the Horizon; and looking on the Index of the Hour Circle, I find it point at 4. a clock and $\frac{1}{6}$ part of an hour more towards 5; therefore I say *May* 10. the Sun rises here at *London* at $\frac{1}{6}$ (which is 12. minutes) after 4 a clock in the Morning.

If you double 4 hours 12. minutes, it gives you the length of the Night, 8 hours 24. minutes. And if you subtract the length of the Night 8. hours 24. minutes, from 24. hours, the length of Day and Night; it leaves the length of the Day 15. hours 36. minutes.

## Prob. VIII.

*To find the Hour of Sun Set.*

Turn the Place of the Sun to the West side of the Horizon, and the Index of the Hour Circle shews on the Hour-Circle the hour of Sun set; which on the 10th of *May* aforesaid, is $\frac{5}{6}$ parts of an hour after 7. a clock at Night, *Viz.* the Sun Sets at 48. minutes past 7. a clock.

## Prob. IX.

### *To find how long it is Twilight in the Morning, and Evening.*

Twilight is that promiscuous and doubtfull light which appears before the Rising of the Sun in the Morning, and continues after the setting of the Sun in the Evening: It is made by the extension of the Suns beams into the Vapours of the Air, when the Sun is less then 18. deg. below the Horizon: for the Sun ere it Rises, and after it Sets, shoots forth its Beams through the Air, and so illuminates the Vapours of the Air; which illumination does by degrees enlighten the Horizon, and spreads through the *Zenith*, even into the West, ere the Sun Rises; and also continues above the Horizon, after the Sun sets.

Now though it be Twilight when the Sun is 18. degrees below the Horizon; yet the duration of Twilight (is alterable both in respect of *Time*) and *Place*; for at such Time as the Sun is farthest distant from any Place, the Twilight shall be greater, then when it is neerest. And in respect of *Place*, All Places that have great Latitude from the Equator, have longer Twilight than those that are neerer to the Equator: for as Authors say, under the Equator there is no Twilight; when again in many Climes both Northward and Southward, the Nights are indeed no Nights, but only (as it were) a little over-spread with a cloudy Shade; and is either increased or diminished according to the position of Meteorological Causes.

Therefore to know the beginning of Twilight in the Morning here at *London*, *May* 10, you must (having the Globe rectified) turn the degree of the *Ecliptick* which is opposite to the Place of the Sun, till it be elevated 18. degrees in the Quadrant of Altitude above the Horizon in the *West*; So shall the Index of the Hour-Circle point at the Hour that Twilight begins: Then subtract the Hour and Minute that Twylight begins from the Hour and Minute of Sun Rising, if in the Morning, or substract the Hour of Sun-set from the Hour of Twilight, if at Night; and the remainder is the length of Twilight.

### Example.

The Globe Quadrant and Hour-Index being rectified, as before;

fore; and the Suns place given, ♉ 29. I ſeek the oppoſite degree on the Globe, after this manner: I bring ♉ 29. to the Meridian, and obſerve what degree of the *Ecliptik* the oppoſite part of the Meridian cuts; and becauſe I find it cuts ♏ 29. therefore I ſay ♏ 29. is oppoſite to ♉ 29. Having found the oppoſite degree, I bring it into the *Weſt*, and alſo the Quadrant of Altitude, and joyn ♏ 29. to 18. degrees (accounted upwards on the Quadrant) ſo ſhall ♉ 29. be depreſſed 18. degrees in the *Eaſt* Side the Horizon: Then looking what Hour the Hour-Index points at in the Hour-Circle, I find it to be, 1. Hor. 8. Min. which ſhews that Twilight begins at 8. Minutes paſt 1. a clock in the Morning.

And if you ſubſtract 1. Hour 8. Minutes, from 4. Hours 11. Minutes, the time of Sun Riſing, found by the 7th. Probleme, it leaves 3. Hours 3. Minutes for the length of Twilight: And if you double 1. Hour 8. Minutes, the beginning of Twilight, it makes 2. Hours 16. Minutes for the intermiſſion of Time between Twilight in the Evening, and Twilight in the Morning. So that *May* 10. abſolute Night is but 2. Hours 16. Minutes long, here at *London*.

The reaſon why you bring the degree oppoſite to the Suns Place to the *Weſt*, is, becauſe the Quadrant containing but 90. degrees will reach no lower then the Horizon; but this Probleme requires it to reach 18. degrees beneath it: therefore by this help, you have the Propoſition Anſwered, as well as if the Quadrant did actually reach 18. degrees below the Horizon. This ſhift you may have occaſion to make in ſome other Problemes.

If you would know when Twilight ends after Sun ſet; you ſhall find it by bringing the degree of the *Ecliptick* oppoſite to the Place of the Sun to 18. degrees of the Quadrant of Altitude, on the *Eaſt* ſide the Horizon; for then ſhall the Index of the Hour-Circle point at 10. Hours 52. Minutes: which ſhews that it continues Twilight till 52. Minutes paſt 10. a clock at Night, *May* 10. here at *London*.

## Prob. X.

*The Suns Place given, to find its* Amplitude; *And alſo to know upon what point of the Compaſs it Riſeth.*

THe Globe &c. rectified: Bring the Suns Place to the *Eaſt* Side the Horizon; and the number of degrees intercepted between

between the *East* point of the Horizon and the *Suns* Place, is the number of degrees of Amplitude that the *Sun* hath at its Rising; and bears its denomination either of *North* or *South*, according to its inclination to either point in the Horizon.

Or, if you would know upon what point of the Compass the *Sun* Rises, Look but in the Circle of Winds; and against the Place of the Sun you have the name of the point of the Compass upon which the Sun Riseth.

## Examples of both.

*May* 10. the Suns Place is ♉ 29. Therefore the Globe being rectified; I bring ♉ 29. to the *East* side the Horizon, and find it touch against 33, degrees 20. Minutes from the *East* point towards the *North*: Therefore I say the *Sun* hath *North* Amplitude 33, degrees 20. Minutes.

And to know upon what point of the Compass the Sun rises; I keep the Globe to its Position, and look in the Circle of Winds, in the outmost verge of the Horizon, and find the Suns Place against the Wind named *North East and by East*; Therefore I say *May* 10. here at *London* the Sun riseth upon the *North East and by East* point of the Compass.

## Probl. XI.

### *The Hour of the Day given, to find the Heigth of the Sun.*

THe Globe &c. Rectified. Turn about the Globe till the Index of the Hour-Circle point (in the Hour-Circle) to the Hour of the Day: Then bring the Quadrant of Altitude to the Suns Place in the *Ecliptick*, and the degree on the Quadrant which touches the Suns Place, shall be the number of degrees of the Suns Altitude.

## Example.

*May* 10. here at *London*; At 53. Minutes past 8. a clock in the Morning, I would know the Heigth of the Sun above the Horizon. Therefore I turn about the Globe till the Index of the

Hour-Circle come to 53. Minutes past 8. a clock (which is almost 9.) in the Hour-Circle: And keeping the Globe to this Position, I bring the Quadrant of Altitude to the Suns place, *viz.* ♉ 29. (found by the third Probleme) and because the Suns Place touches upon 40. degrees of the Quadrant, therefore I say *May* 10. 53. Minutes past 8. a clock in the Morning, here at *London*, The Sun is just 40. degrees above the Horizon; or which is all one, hath 40. degrees of Altitude.

## PROB. XII.

*The Altitude of the Sun, and Day of the Moneth given, to find the Hour of the Day.*

*An Hour defined.*

AN Hour is the 24th. part of a Day and a Night, or the space of time that 15. degrees of the Equator takes up in passing through the Meridian; for the whole Equator which contains 360. degrees, passes through the Meridian in 24. Hours, therefore 15. degrees which is the 24th. part of 360, pass through in one Hour. These Hours are Vulgarly divided into halfs, quarters, and half quarters; but Mathematically into Minutes, Seconds, Thirds, Fourths, &c. A Minute is the 60th. part of an Hour, so that 60. minutes make an Hour, 30, half an Hour, 15. a quarter of an Hour. A Second is the 60th part of a Minute: a third is the 60th part of a Second: a Fourth is the 60th part of a Third: and so you may run on to Fifths, Sixths, Sevenths, &c. if you please. 12. of these Hours make a Day, and 12. more make a Night: so that Day and Night contain 24. hours, as aforesaid; which are Vulgarly numbred from Noon with 1, 2, 3, till 12. at Night, and then begin again with 1, 2, 3, till 12. at Noon. But by Astronomers they are Numbred from Noon with 1, 2, 3, &c. to 12. at Night, and so forward to 13, 14, 15, till 24; which is just full Noon the next Day. Yet in this Treatise I shall mention the Hours as they are Vulgarly Numbred, *viz.* from 1. after noon, to 12. at Night, and call the Hours after Midnight by 1, 2, 3, 4, &c. in the Morning, to 12. at Noon again, the next Day. But to the operation.

*Minutes, Seconds, and Thirds, &c. defined.*

The Globe, &c. Rectified, Bring the Place of the Sun to the Number of degrees of Altitude accounted upon the Quadrant of Alti-

Altitude, and the Hour-Index ſhall point at the Hour in the Hour-Circle: yet herein reſpect muſt be had to the Fore or After noons Elevation; as ſhall be ſhewed in the next Probleme.

### Example.

*May* 10. The Sun is elevated 40. degrees above the Horizon, here at *London:* Therefore having found the Place of the Sun, by the third Probleme, to be ♉ 29. I move the Globe and Quadrant till I can joyn the 29. degree of ♉ to the 40. deg. upon the Quadrant of Altitude; and then looking on the Hour-Circle, I find the Index point at 53. Minutes paſt 8. a clock, for the Fore noon Elevation; and at 3. hours 7. Minutes for the After noons Elevation. Therefore if it be Fore-noon, I ſay, It is 53. Minutes paſt 8. a clock in the Morning. But if it be After noon I ſay, It is 7. Minutes paſt 3. a clock in the After noon.

## Prob. XIII.

### *How to know whether it be Before or After Noon.*

HAving made one Obſervation, you muſt make a Second a little while after the Firſt; and if the *Sun* increaſe in Altitude, it is Before Noon: but if it decreaſe in Altitude, it is After Noon.

### Example.

The Sun was at 8. hor. 53. Min. elevated 40. degr. above the Horizon: A little while after (ſuppoſe for examples ſake a quarter of an hour,) *viz.* at 9. hor. 8. Min. I obſerve again the heigth of the Sun, and find it 42. degrees high; ſo that the Altitude is increaſed 2. degrees; Therefore I ſay, It is Fore-Noon: But if the Sun had decreaſed in Altitude, I ſhould have ſaid it had been After-Noon.

### *How to take Altitudes by the* Quadrant, Aſtrolabe, *and Croſs-ſtaff.*

There are divers Inſtruments whereby Altitudes may be taken: but the moſt in uſe are the *Quadrant*, *Aſtrolabe*, and *Croſs-ſtaff*. A *Quadrant* is an Inſtrument comprehended between two Straight lines making a Right Angle, and an Arch

Arch discribed upon the Right Angle, as on the Center, containing 90. degrees, which is a quarter of a Circle: and therefore the Instrument is called a *Quadrant*. See this Figure.

A prepresents the Center; upon which is fastned a Plumb-line, A B the one side, A C the other side, upon which the Sights are placed: B C the Arch or Quadrant, which is divided into 90. equal parts, and numbred from B to C. D one Sight, E the other Sight: F the Plumbet fastned to the Plumb-line.

When by this Instrument you would observe the heigth of the Sun, you must turn the Center A to the Sun, and let the beams thereof dart in at the hole in the first Sight D, through the hole in the second Sight E; so shall the Plumb-line ly upon the degree in the Limb, of the Suns Elevation: As if the plumb-line ly upon the 20th degree, then shall the Altitude be 20. degrees; if on 25. the Altitude shall be 25. degrees: and so for any number of Degrees the thred or Plumb-line lies on, the same number of Degrees is the Altitude of the Sun.

But

But if it be a Star whoſe Altitude you would obſerve; you muſt hold up the Quadrant, and joyn the Limb to your Cheek bone, and turn the Center towards the Star: then winking with one Ey, look through the holes of the Sights with the other Ey, till you can ſee the Star through thoſe holes; ſo ſhall the Plumb-line (as before in the Sun) hang upon the degree in the Limb of the Stars Elevation.

Another ſort of Quadrants is made with a moveable Index, as is repreſented in this Figure.

A is the Center, A B and A C the two ſides, B C the Limb, D E two Sights fixed upon a moveable Index or Label; F G two other Sights, for obſerving the Horizon.

When by this Quadrant you would obſerve an Altitude, the ſide B A muſt be parallel to the Horizon, and the Index muſt be moved till the Object (be it either the Sun Moon or any Star) be ſeen through the holes or ſlits of the Sights placed on the Index; for then the Arch D B ſhall be the Elevation required. You

may know when the side B A is parallel to the Horizon, by observing the parting of Heaven from the Earth through the Sights on the Side B A.

## *To take Altitudes by the* Astrolabe.

The Astrolabe is a round Instrument, flat on either side, upon one of the flats or Plains is discribed a Circle as B C D E, divided into 360. equal parts or degrees, numbred from the line of Level B A C, with 10, 20, 30, &c. to 90. in the Perpendicular D C. Upon the perpendicular is fastned a Ring as F, so as the Instrument hanging by it, the line of Level may hang parallel to the Horizon. Upon the Center is a moveable Label or Ruler, as G H, whereupon is placed two Sights as I K.

If you desire further instructions for making this Instrument, you may peruse Mr. *Wright* in his *Division of the whole Art of*

*of Navigation*, annexed to his *Correction of Errors*: where he alſo ſhews the uſe of it at large; which in brief is as follows.

You muſt hold the *Aſtrolabe* by the Ring in your left hand, and turning your right ſide to the Sun, lift up the Label with your right hand, till the beams of the Sun entring by the hole of the uppermoſt Vane or Sight, doth alſo pierce through the hole in the nethermoſt Vane or Sight; and the deg. and part of deg. that the Label lies on is the height of the Sun above the Horizon.

But if it be a Star you would obſerve; you muſt uſe the *Aſtrolabe* as you were directed to uſe the *Quadrant*, holding it up to your Cheek bone, and looking through the Sights, &c.

## To take Altitudes by the *Croſs-ſtaff*.

This Inſtrument conſiſts of a Staf about a yard long, and three quarters of an inch ſquare: Upon it is fitted a Vane, (or ſometimes two, or three,) ſo as it may ſlide pretty ſtiff upon the Staff, and ſtand at any of the Diviſions it is ſet to.

The making is taught by Mr *Wright*, aforesaid: But the use is as follows.

You must put that end of the *Cross-staff* which is next 90. degrees to your Cheek bone, upon the outter corner of your Ey, and holding it there steddy, you must move the Vane till you see the Horizon joyned with the lower end thereof, and the Sun or Star with the higher end; then the degree and part of degree which the Vane cutteth upon the Staff, is the height of the Sun or Star.

Some of these waies for taking Altitudes have been formerly taught by others, that have treated upon the Use of Globes: and therefore because some would be apt to think this Treatise uncompleat if I did not shew these waies also, I have thought fit to insert them: Yet the same things may be performed by the Globe alone, without troubling your self with multiplicity of Instruments; if your Globe be made with a hollow Axis; for then if the Globe stand Horizontal, you shall by Observing the Object through the Axis have the degree of Elevation, noted by the superficies of the Horizon.

## Prob. XIV.

### *To observe with the Globe the Altitude of the Sun.*

PLace the Globe so that the upper plain of the Horizon may stand parallel to the Plain of the Horizon of your Place; as was taught by the Second Probleme; then turn the North Pole towards the Sun, and place it higher or lower, by moving the Meridian through the notches of the Horizon, till the beams of the Sun pierce quite through the Axis of the Globe: So shall the arch of the Meridian comprehended between the Pole and the Horizon, be the number of Degrees that the Sun is elevated above the Horizon.

### Example.

*March* 20. just at noon, here at *London*, I would observe the Meridian Altitude of the Sun. Therefore placing the Horizon Horizontal, as by the Second Probleme: I turn the North Pole

Pole towards the Sun, and move it with the Meridian upwards or downwards, either to this ſide or that, till I can fit it to ſuch a Poſition that the Sun Beams may dart quite through the Axis of the Globe; which when it does, I look on the Meridian and find 42. degrees 25. min. comprehended between the Pole and the ſuperficies of the Horizon; Therefore I ſay the Meridian Altitude of the Sun *March* 20. here at *London*, is 42. degrees 25. min.

## PROB. XV.

### *To find the Elevation of the Pole, by the Meridian Altitude of the Sun, and Day of the Moneth given.*

THE Day of the Moneth is *March* 20. By the 4th Prob. you may find the place of the Sun to be ♈ 10. Therefore bring the Place of the Sun to the Meridian, and elevate it above the Horizon the ſame number of degrees it hath in Heaven; ſo ſhall the arch of the Meridian comprehended between the Pole and the Horizon, be the elevation of the Pole, in your Place.

### Otherwiſe.

The Day of the Moneth given is *March* 20. ſo that by the fourth Prob. you have the Suns Place ♈ 10; and by the fifth, the Declination of the Sun 3. 55. North: therefore the Declination being North, and you on the North ſide the Equator; you muſt ſubſtract 3. 55. from the Meridian Altitude 42. 25. and there remains 38. 30. for the heighth of the Equinoctial above the Horizon; but if your Declination had been South, you muſt have added 3. 55. to the Meridian Altitude, and the Sum would have been the Elevation of the Equinoctial. Having the Elevation of the Equinoctial, you may eaſily have the Elevation of the Pole; for the one is alwaies the Complement of the other to 90. Thus the Height of the Equinoctial 38. 30. ſubtracted from 90. leaves 51. 30. for the Elevation of the Pole, here at *London*. And thus it follows, that the Latitude of any Place from the Equinoctial, is alwaies equal to the Elevation of the

Pole: for between the *Zenith* and the Equinoctial is contained the Complement of the Heighth of the Equinoctial above the Horizon to 90.

## Prob. XVI.

### *To take the Altitude of any Star above the Horizon; by the Globe.*

THe Horizon of the Globe ſet parallel to the Horizon of the World, as before: Turn the North Pole towards the Star, and when you can ſee the Star th rough the Axis, the Northern notch of the Horizon will cut the d egree of Elevation on the Meridian.

### Example.

*April* 19. at 11. a clock at Night, I would obſerve the Altitude of *Spica Virgo*: Therefore I ſet the Horizon parallel to the Horizon of the World, as by the Second Probleme, and turn the Northern Pole till it point towards the Star: Then looking in at the South Pole of the Globe through the Axis, I ſhall ſee the Star, and have on the Meridian the Queſtion reſolved. But if it point not exactly, then I move the North Pole upwards or downwards, either to the right hand, or to the left, according as I may find occaſion, till I can ſee the Star through the Axis: and then the edge of the notch in the Horizon cuts 28. degrees 57. min. on the Brazen Meridian. Therefore I ſay *April* 19. at 11. a clock at Night, here at *London*, the Altitude of *Spica* ♍ is 30. degrees above the Horizon.

## Prob. XVII.

### *By the Meridian Altitude of any Star given, to find the Height of the Pole.*

JOyn the *Star* to the Meridian, and place it to the Altitude obſerved; ſo ſhall the number of degrees intercepted between the Pole and the Horizon, be the Elevation of the Pole.

Exam-

## Example.

*Spica Virgo* is obſerved to have 28. degrees 57. min Meridian Altitude; therefore I bring *Spica Virgo* to the Meridian, and raiſe it or depreſs it higher or lower as I find occaſion, till it is juſt 28. degrees 57. min. above the Horizon: Then I count the number of degrees between the Pole and the Horizon, and find them $51\frac{1}{2}$. Therefore I ſay the Elevation of the Pole is here at *London* $51\frac{1}{2}$. Yet note, If the Star whoſe Altitude you obſerve have fewer number of degrees of Declination from the Pole, then the Elevation of the Pole, you may be apt to miſtake in its coming to the Meridian; for thoſe Stars never ſet; and therefore are twice Viſible in the Meridian in 24. hours, once above the Pole, and once under the Pole.

If your Star have greater Altitude then the North Star, it is above the Pole; but if it have leſs, it is below the Pole: ſo that if you know but whether it be above or below, it is enough; for ſo you may accordingly raiſe it to the Altitude on the Meridian it hath in Heaven, and joyn it to the Meridian either above or beneath the Pole, as the Star is placed in Heaven: and then the arch of the Meridian comprehended between the Pole and the Horizon, is the Elevation of the Pole: as aforeſaid.

## Otherwiſe.

Having the Meridian Altitude of the Star, you muſt find its Declination by the 27. Probleme: and if the Declination be South, and you on the North ſide the Equator, you muſt ad the Declination to the Meridian Altitude, and the ſum of both makes the Altitude of the Equinoctial: But if the Declination be North, and you on the North ſide the Equator, you muſt ſubſtract the Declination from the Meridian Altitude, (as was taught by the 15. Prob. in the Example of the Sun) and the remainder is the Altitude of the Equinoctial Then (as was taught by the 15 Probleme aforeſaid) ſubſtract the Altitude of the Equinoctial from 90. the Remainder is the Elevation of the Pole in your Place.

Exam-

## Example.

By the last Probleme the Meridian Altitude of *Spica Virgo* was 28. degrees 57. min. and the Declination of *Spica* by the 27th Probleme is found 9. degrees 33. min. South: therefore because the Declination is South, I ad 9. degrees 33. min. to the Meridian Altitude, which makes 38. deg. 30. min. for the Elevation of the Equinoctial: which 38. deg. 30. min. substracted from 90. leaves 51. degrees 30. min. for the Elevation of the Pole here at *London*.

## Prob. XVIII.

*Another way to find the Height of the Pole by the Globe; if the Place of the Sun be given: and also to find the Hour of the Day, and Azimuth, and Almicantar of the Sun.*

This must be performed by help of a *Spherick Gnomon*, (as *Blaew* calls it,) which is a small Pin or Needle fixed perpendicularly into a smal Basis with an hollow concave bottom, that it may stand upon the convexity of the Globe. Therefore the Horizon of the Globe being set parallel to the Horizon of the World, (as by the Second Probleme) the *Spherick Gnomon* must be set exactly upon the Place of the Sun; and then turning the Globe about (upon its Axis) either from *East* to *West*, or contrarily from *West*, to *East*; or else by the Meridian, through the notches of the Horizon, till the *Spherick Gnomon* cast no shadow on any side thereof; you have on the Meridian in the North point of the Horizon the number of degrees that the Pole is elevated above the Horizon.

## Example.

Imagine the four Quarters of the Horizon of the Globe correspond with the four Quarters of the Horizon of the World; and the Plain of the Horizon of the Globe is parallel to the Plain of the Horizon of the World: The Suns Place is ♉ $29^{d}_{\frac{1}{4}}$. which

which I find on the Globe, and place the *Spherick Gnomon* thereon; Then at a gueſs I move the Globe both on its Axis, and by the Meridian, (as neer as I can) ſo as the *Spherick Gnomon* may caſt no ſhadow; yet if it do, and the ſhadow fall towards the North Pole; then I elevate the North Pole more, till the ſhadow fals juſt in the middle of it ſelf: but if the ſhadow fall downwards, towards the South Pole, then I depreſs the North Pole: If the ſhadow fall on the *Eaſt* ſide, I turn the Globe on its Axis more to the *Weſt*; and if the ſhadow fall to the *Weſt*, I turn the Globe more into the *Eaſt*: and the degree of the Meridian which the North point of the Horizon touches, is the degree of the Poles Elevation: which in this Example is 51½. the Latitude of the City of *London*.

By this Operation you have alſo given the Hour of the Day in the Hour-Circle, if you keep the Globe unmoved: and the *Azimuth*, and *Almicantar*, if you apply but the Quadrant of Altitude to the Place of the Sun, as by the 22, and 23. Problemes.

## Prob. XIX.

### *To obſerve by the Globe the Diſtance of two Stars.*

You muſt pitch upon two Stars in the Meridian; and obſerve the Altitude of one of them firſt, and afterwards the Altitude of the other: Then ſubſtract the leſſer Altitude from the greater, and the remainder ſhall be the diſtance required.

### Example:

*March* 7. at 11. a clock at Night here at *London*, I ſee in the Meridian the two Stars in the foremoſt *Wheels* of the *Waggon*, in the Conſtellation of the *Great Bear*, called by Sea-men the *Pointers*, (becauſe they alwaies point towards the Pole-Star.) Therefore to obſerve the diſtance between theſe two Stars, I firſt obſerve (as by the laſt Probleme) the Altitude of the moſt Northern to be 77. degree 59. minutes, and ſet down that number of Degrees and minutes with a Pen and Ink on a Paper, or with a peece of Chalk or a Pencil on a Board: and afterwards I obſerve the Altitude of the other Star which is un-

der it, as I did the firſt, to be 83. deg. 21. min. and ſet that number of degrees and minutes alſo down, under the other number of degrees and minutes: Then by ſubſtracting the leſſer from the greater, I find the remainder to be 5. degrees 22. min. which is the diſtance of the two Stars in the *Great Bear*, called the *Pointers*.

## Prob. XX.

*How you may learn to give a gueſs at the number of degrees that any two Stars are diſtant from one another; or the number of degrees of Altitude the Sun or any Star is elevated above the Horizon: only by looking up to Heaven, without any Inſtrument.*

BEtween the *Zenith* and the Horizon is comprehended an Arch of a Circle containing 90. degrees; ſo that if you ſee any Star in or neer the *Zenith*, you may know that Star is 90. or neer 90. degrees high; and by ſo much as you may conceive it wants of the *Zenith*, ſo much you may gueſs it wants of 90. degrees above the Horizon. By this Rule you may gueſs at an Arch of Heaven containing 90. degrees, or at an Arch of Heaven containing 45. degrees; if by your imagination you divide the whole Arch into two equal parts, for then ſhall each of them contain 45. degrees; And if by your imagination you divide the Arch of 90. into 3. equal parts, each diviſion ſhall contain an Arch of 30. degrees, &c. But this way is a little too rude for gueſſing at Stars elevated but few degrees, or for Stars diſtant but few degrees from one another. Therefore that you may learn to gueſs more preciſely at Diſtances in Heaven, you may either with a *Quadrant*, *Aſtrolabe*, or the *Globe*; find the exact diſtance of any two known Stars that are but few degrees aſunder, and by a little revolving the diſtance of thoſe Stars in your fancy, you may at length ſo imprint their diſtance in your memory, that you may readily gueſs the diſtance of other Stars by the diſtance of them.

### Example.

You may find either by the *Globe*, *Quadrant*, or *Aſtrolabe*, (for

(for they all agree) 3. degrees comprehended between the first Star in *Orions Girdle*, and the last; therefore by a little ruminating upon that distance, you may imprint it in your fancy for 3. degrees, and so make it applicable to other Stars, either of the same distance, or more, or less: And the *Pointers* (by the last Probleme) are distant from one another 5. degrees and almost an half: These are alwaies above our Horizon, and therefore may alwaies stand as a Scale for five and an half degrees; So that by these for $5\frac{1}{2}$ degrees, and those in *Orions Girdle* for 3. degrees, and others observed, either of greater or lesser distance, you may according to your own Judgement shape a guess, if not exactly, yet pretty neer the matter of Truth, when you come to other Stars. Thus you may exercise your fancy upon Stars found to be 10. or 15. degrees asunder, or more, or less; and with a few experiments of this nature enure your Judgement to guess distances, and enable your memory to retain your Judgement.

This way of guessing will be exact enough for finding the Hour of the Night by the Stars, for most common Uses; or the Hour of the Day, by guessing at the Altitude of the Sun; if after you have guessed at the Altitude, you shall work as was taught by Prob. 12. for the Hour of the Day: and as shall be taught in the next Probleme, for the Hour of the Night.

## Prob. XXI.

### *The Day of the Moneth, and Altitude of any Star given, to find the Hour of the Night.*

THe Globe, Quadrant, and Hour Index rectified: Bring the Star on the Globe to the same number of Degrees on the Quadrant of Altitude that it hath in Heaven: So shall the Index of the Hour-Circle point in the Hour-Circle at the Hour of the Night.

### Example.

*March* 10. the Altitude of *Arcturus* is 35. degrees above the Horizon, here at *London*: Therefore having the Globe,

Quadrant and Hour-Index rectified, I bring *Arcturus* on the Globe to 35. degrees on the Quadrant of Altitude: And then looking in the Hour-Circle, I find the Index point at 10. a clock; which is the Hour of the Night.

## Prob. XXII.

### *The Place of the Sun, and Hour of the Day given, to find its Azimuth in any Latitude aſſigned.*

The Globe, &c. rectified to your Latitude: Turn the Globe till the Index of the Hour-Circle come to the given hour; and bring the Quadrant of Altitude to the Place of the Sun: ſo ſhall the number of degrees contained between the Eaſt point of the Horizon and the degree cut by the Quadrant of Altitude on the Horizon, be the number of degrees of the Suns Azimuth, at that time,

### Example.

*May* 10. at 53. minutes paſt 8. a clock in the Morning, I would know the Azimuth of the Sun: Therefore (the Globe being firſt rectified) I turn about the Globe till the Index of the Hour-Circle point to 53. minutes paſt 8. a clock, or which is all one, within half a quarter of an hour of 9; then I move the Quadrant of Altitude to the degree the Sun is in that Day, and there let it remain till I ſee how many degrees is contained between the *North* point and the Quadrant; which in this Example is 108. deg. 25. min. And becauſe this diſtance from the *North*, exceeds 90. degrees; therefore I ſubſtract 90. degrees from the whole, and the remains is 18. degrees 25. min. for the Azimuthal diſtance of the Sun from the *Eaſt* point towards the *South*. But if it had wanted of 90. degrees from the North point, then ſhould the Complement of 90. have been the Azimuthal diſtance of the Sun from the Eaſt point.

Prob.

## PROB. XXIII.

### *The Place of the Sun, and hour of the Day given, to find the Almicantar of the Sun.*

THe Almicantars of the Sun is upon the matter the ſame thing with the Altitude of the Sun: only with this diſtinction. The Almicantars are Circles parallel to the Horizon, diſcribed by the degree of the Quadrant of Altitude upon the *Zenith* as its Center, by turning the Quadrant round about the Globe till it comes again to its firſt Place: But the Altitude is an Arch of the Vertical Circle, comprehended between the Horizon and any point of the Globe aſſigned. Their agreement conſiſts in this; When the Sun or any Star hath any known Almicantar, they are ſaid to have the ſame number of degrees of Altitude; As if the Sun be in the 20th Almicantar; he hath 20 degrees of Altitude; if in the 30th Almicantar, he hath 30. degrees of Altitude, &c. Now becauſe the Operation is the ſame for finding the Altitude and Almicantar, I ſhall refer you to the 11th Probleme; which ſhews you how to find the Altitude or Heighth; and by conſequence the Almicantar.

## PROB. XXIV.

### *The Place of the Sun given, to find what Hour it comes to the* Eaſt, *or* Weſt, *and what Almicantar it then ſhall have.*

THe Globe, Quadrant, and Hour Index rectified, Bring the Quadrant of Altitude to the *Eaſt* point in the Horizon, if you would know what hour it comes to the *Eaſt*; or to the *Weſt* point, if you would know what hour it comes to the *Weſt*: Then turn about the Globe till the place of the Sun come to the Quadrant of Altitude; and the Index of the Hour Circle ſhall point at the hour of the Day: which on the Day aforeſaid will be 7. hor. 7 min. in the Morning, that the Sun commeth to the *Eaſt*, and 4 hor. 53. min. after noon, that the Sun commeth to the Weſt. And if you then count the number of degrees from

the Horizon upwards on the Quadrant of Altitude, it will ſhew you the Almicantar of the Sun for that time; which will both Morning and Evening be 15, deg. 30. min. as was taught you by the laſt Probleme.

## Prob. XXV.

### *To know at any time what a clock it is in any other Part of the Earth.*

THe difference of Time is reckoned by the acceſs and progreſs of the Sun: for the Sun gradually circumvolving the Earth in 24. hours, doth by reaſon of the Earths rotundity enlighten but half [redacted] at one and the ſame moment of Time; as ſhall be ſhewed hereafter: ſo that hereby it comes to paſs, that when with us here in *England* it is 6. a clock in the Morning, with thoſe that have 90. degrees of Longitude to the Weſtward of us, it is yet Midnight: with thoſe that have 180. degrees of Longitude from us, it is Evening; And with thoſe that have 90. degrees of Longitude to the *Eaſtwards*, it is Noon. So that thoſe to the *Eaſtward* have their Day begin ſooner then ours: But to the *Weſtward* their Day begins after ours. Therefore that you may know what Hour it is in any Place of the Earth, of what diſtance ſoever it be, you muſt firſt Bring the Place of your own Habitation to the Meridian, and the Index of the Hour Circle to 12. on the Hour Circle; Then bring the other Place to the Meridian, and the Arch of the Hour Circle comprehended between the hour 12. and the Index, is the difference in Time between the two Places.

### Example.

*London* in *England*, and *Surat* in the *Eaſt Indies*: Firſt I bring *London* to the Meridian, and turn the Index of the Hour-Circle to 12; then I turn the Globe *Weſtward*, becauſe *London* is *Weſtward* of *Surat*, till *Surat* come to the Meridian; and ſee at what Hour the Index of the Hour Circle points, which in this Example is 5. hor. 54. minutes: And becauſe *Surat* lies to the *Eaſtward* of us ſo many degrees, therefore as was ſaid before, their

their Day begins ſo much before ours: So that when here at *London* it is 6. a clock in the Morning, at *Surat* it will be 11. a clock 54. minutes; when with us it is 12. a clock, with them it will be 5 a clock 54. minutes afternoon.

If you would know the difference of Time between *London* and *Jamaica*; Working as before, you may find 5. hor. 15. min. But *Jamaica* is to the *Weſt* of *London*; therefore their Day begins 5. hor. 15. min. after ours: ſo that when with us it is Noon, with them it will be but three quarters of an hour paſt 6. a clock in the Morning: and when with them it is Noon, with us it will be one quarter paſt 5. a clock after Noon, &c.

Or you may yet otherwiſe know the difference of Time, if you divide the number of Degrees of the Equinoctial that paſs through the Meridian while the Globe is moved from the firſt Place to the ſecond, by 15. ſo ſhall the product give you the difference of hours and minutes between the two Places: as you will find if you try either of theſe Examples, or any other.

## PROB. XXVI.

### *To find the Right Aſcenſion of the Sun, or Stars.*

THE Right Aſcenſion of any point on the Globe is found by bringing the point propoſed to the Meridian, and counting the number of degrees comprehended between the *Vernal Colure*, and the Meridian.

### Example, for the Sun.

*June* 1. I would know the Right Aſcenſion of the Sun: His Place found, as by the third Probleme, is ♊ 20. Therefore I bring ♊ 20. to the Meridian; and then the Meridian cuts the Equinoctial in 79. degrees 15. minutes, accounted from the *Vernal* point ♈: Therefore I ſay the Right Aſcenſion of the Sun *June* 1. is 79. deg. 15. Minutes.

### Example, for a Star.

I take *Capella*, alias *Hircus*, the *Goat* on *Auriga's ſholder*, and

and bring it to the Meridian; and find the Meridian cut the Equinoctial (counting as before from the *Vernal* point ♈) in 73. degrees 58. minutes: Therefore I say, the Right Ascension of *Hircus* is 73. degrees 58. min. Do the like for any other point of the Globe proposed.

## Prob. XXVII.

### *To find the Declination of the Sun, or Stars.*

The Declination of any point on the Globe is found by bringing the point proposed to the Meridian, and counting the number of degrees comprehended on the Meridian between the Equinoctial and the point proposed: and bears its Denomination of *North* or *South*, according as it is scituate on the *North* or *South* side the Equinoctial.

### Example, for the Sun.

*June* 1. I would know the Declination of the Sun. His Place found, as before, is ♊ 20. Therefore I bring ♊ 20. to the Meridian; and find 23. degrees 8. min. comprehended on the Meridian between the Equinoctial and ♊ 20. and because ♊ is on the *North* side the Equinoctial; Therefore I say, *June* 1. The Sun hath *North* Declination 23. degrees 8. minutes.

### Example, for a Star.

I take *Hircus* aforesaid, and bring it to the Meridian, and find 45. degrees 40. minutes comprehended on the Meridian between the Equinoctial and the Star *Hircus*. And because *Hircus* is on the *North* side the Equinoctial; Therefore I say, *Hircus* hath *North* Declination 45. degrees 40. min. Do the like for any other point on the Globe proposed.

But Note, The Right Ascension and Declination of the Sun alters dayly; for in twelve Moneths he runs through every degree of Right Ascension, and in three Moneths to his greatest Declination: But the Right Ascension and Declination of the Stars is scarce perceiveable for some Years: Yet have they also an alteration of Right Ascension and Declination: For, those Stars

that

that have but few degrees of Right Aſcenſion, will in proceſs of Time have many; and thoſe Stars between the Tropick that have North Declination, will in length of Time have South Declination; and the contrary (as ſhall be more fully ſhewed hereafter:) For, the Stars moving upon the Poles of the *Ecliptick*, go forwards in Longitude one whole Degree in $70\frac{1}{2}$ Years (as hath been ſhewed before, *Book* 1. *Chap.* 3. *Sect.* 3.) and ſo alter both their Right Aſcenſion, and Declination; as may be ſeen by this following Table of Right Aſcenſions and Declinations of 100. of the moſt eminent fixed Stars, Calculated by *Tycho Brahe*, for the Years 1600. and 1670. which I have inſerted; partly, becauſe by it you may ſee the differences of their Right Aſcenſions and Declinations in $70\frac{1}{2}$. Years; and partly to Accomodate thoſe that may have occaſion to know their Right Aſcenſions and Declinations neerer than the Globe can ſhew them.

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*A Table of the Right Aſcenſions and Declinations of* 100. *Select fixed Stars; Calculated by* Tycho Brahe, *for the Years* 1600, *and* 1670. *As alſo their Difference of Right Aſcenſions and Declinations, in* 70. *Years.*

| | 1600 | | | Differentia. | | 1700 | |
|---|---|---|---|---|---|---|---|
| *Names of the Stars.* | *R. Aſc.* | *Declin.* | | *R. Aſ.* | *Decl.* | *R. Aſc.* | *Declin.* |
| Scedir, *in Caſſiopeæ.* | 4 36 | 54 21 | *N* | 1 22 | 34 *S* | 5 58 | 54 55 |
| *The Pole Star.* (*tail.* | 5 47 | 87 $9\frac{1}{2}$ | *N* | 3 59 | 34 *S* | 9 46 | 87 $43\frac{1}{2}$ |
| *Southern in the whales* | 5 51 | 20 12 | *S* | 1 17 | 34 *N* | 7 8 | 19 38 |
| *Caſſiopeæ's Belly.* | 8 21 | 58 33 | *N* | 1 27 | 34 *S* | 9 48 | 59 7 |
| *Girdle Andromeda.* | 11 50 | 33 32 | *N* | 1 23 | 33 *S* | 13 13 | 34 5 |
| *Knee of Caſſiopeæ.* | 15 3 | 58 7 | *N* | 1 35 | 33 *S* | 16 38 | 58 40 |
| 1. *in* ♈ *horn.* | 22 56 | 17 19 | *N* | 1 23 | 31 *S* | 24 19 | 17 50 |
| *Whales belly.* | 22 59 | 12 16 | *S* | 1 15 | 31 *N* | 24 14 | 11 45 |
| 2. *in* ♈ *horn.* | 23 10 | 18 50 | *N* | 1 22 | 31 *S* | 24 32 | 19 31 |
| *South foot of Andromeda.* | 24 55 | 40 23 | *N* | 1 29 | 30 *S* | 26 24 | 40 53 |

| *Names of the Stars.* | 1600 R. Asc. | 1600 Declin | | Differentia. R. Asc. | Differentia. Decl. | 1700 R. Asc. | 1700 Declin. |
|---|---|---|---|---|---|---|---|
| *In the Knot in the line* ♐. | 25 22 | 0 50 | *N* | 1 18 | 30 *S* | 26 40 | 1 20 |
| ✱ *Star in* ♈ *head.* | 26 23 | 21 33 | *N* | 1 25 | 30 *S* | 27 38 | 22 3 |
| ✱ *In the whales jaw.* | 40 25 | 2 29 | *N* | 1 15 | 25 *S* | 41 40 | 2 54 |
| Caput Medusæ | 40 38 | 39 22 | *N* | 1 37 | 25 *S* | 42 15 | 39 47 |
| ✱ *In Perseus side.* | 44 2 | 48 22 | *N* | 1 28 | 21 *S* | 45 30 | 48 43 |
| ✱ *In the* Pleiades. | 50 57 | 22 49 | *N* | 1 29 | 21 *S* | 52 26 | 23 10 |
| *In the Nostrils of* ♉. | 59 16 | 14 37 | *N* | 1 25 | 17 *S* | 60 41 | 14 54 |
| *North Ey of* ♉. | 61 21 | 18 14 | *N* | 1 24 | 17 *S* | 62 45 | 18 31 |
| Aldebaran. | 63 16½ | 15 38 | *N* | 1 26½ | 15 *S* | 64 43 | 15 53 |
| Hircus, Capella. | 71 49 | 45 30 | *N* | 1 49 | 10 *S* | 73 38 | 45 40 |
| ✱ *Orions foot*, Rigel. | 73 51½ | 8 43 | *S* | 1 15½ | 9½ *S* | 75 7 | 8 33½ |
| *North Horn* ♉. | 75 16 | 28 12 | *N* | 1 37 | 8 *S* | 76 53 | 28 20 |
| *Orions left sholder.* | 75 58 | 5 55 | *N* | 1 19 | 8 *S* | 77 17 | 6 3 |
| *Belly of the Hare* | 77 48 | 21 6 | *S* | 1 5 | 7 *N* | 78 53 | 20 59 |
| 1. *In Orions Girdle* | 77 58 | 0 39 | *S* | 1 17 | 7 *N* | 79 15 | 0 32 |
| *Uppermost in Orions face* | 78 21 | 9 36 | *N* | 1 22 | 7 *S* | 79 41 | 0 43 |
| *South Horn* ♉. | 78 26 | 20 51 | *N* | 1 31 | 7 *S* | 79 57 | 20 58 |
| 2. *In Orions Girdle.* | 79 1 | 1 30 | *S* | 1 17 | 6 *N* | 80 18 | 1 24 |
| *Last in Orions Girdle.* | 80 10 | 2 12 | *S* | 1 16 | 5 *N* | 81 26 | 2 7 |
| *Auriga's right Sholder.* | 82 40 | 44 50 | *N* | 1 55 | 4 *S* | 84 35 | 44 54 |
| *Orions right Sholder.* | 83 26 | 7 16 | *N* | 1 22 | 4 *S* | 84 48 | 7 20 |
| ✱ *Foot* ♊. | 93 38 | 16 40 | *N* | 1 28 | 2 *N* | 95 6 | 16 38 |
| *Great Dog.* Sirius. (*Twin.* | 96 53 | 16 11 | *S* | 1 7 | 4 *S* | 98 0 | 16 15 |
| *Head of Castor, the first* | 107 9 | 32 41 | *N* | 1 44 | 11 *N* | 108 53 | 32 30 |
| *The little Dog*, Procyon. | 109 37 | 6 12 | *N* | 1 20 | 12 *N* | 110 57 | 6 0 |
| *Head Pollux, second Twin.* | 110 13 | 28 55 | *N* | 1 34 | 12 *N* | 111 47 | 28 43 |
| ✱ *In the Stern of the* | 117 39 | 23 11 | *S* | 1 4 | 15 *S* | 118 43 | 23 26 |
| Præsepe ♋ (*Ship.* | 124 20 | 21 2 | *N* | 1 28 | 19 *N* | 125 48 | 20 43 |
| *Northern Asse* ♋ | 124 58 | 22 51 | *N* | 1 30 | 20 *N* | 126 28 | 22 31 |
| *Southern Asse* ♋ | 125 27 | 19 35 | *N* | 1 27 | 20 *N* | 126 54 | 19 15 |
| *The Heart of Hydra.* | 137 1 | 6 57 | *S* | 1 15 | 25 *S* | 138 16 | 7 22 |
| *South of* ζ. *in neck* ♌ | 146 22 | 18 42 | *N* | 1 28 | 28 *N* | 147 50 | 18 14 |
| *Lions Heart*, Basiliscus. | 146 45½ | 13 53½ | *N* | 1 53½ | 28 *N* | 148 8 | 13 25 |
| *North of* ζ. *in neck* ♌ | 148 33 | 25 23 | *N* | 1 23 | 29 *N* | 150 1 | 24 54 |
| *Middle of* ζ. *in neck* ♌ | 149 25½ | 21 50 | *N* | 1 50 | 29 *N* | 150 51 | 21 21 |

| Names of the Stars. | 1600 R. Asc. | 1600 Declin. | | Differentia. R. Asc. | Differentia. Decl. | | 1700 R. Asc. | 1700 Declin. |
|---|---|---|---|---|---|---|---|---|
| First lowest in ☐ Vrsa Maj. | 159 12 | 58 31 | N | 1 37 | 32 N | | 160 49 | 57 59 |
| First upper in ☐ Dubbe | 159 37 | 63 54 | N | 1 41 | 32 N | | 161 18 | 63 22 |
| ♀ back ♑. | 163 10 | 22 43 | N | 1 27 | 34 N | | 164 37 | 22 9 |
| Lions tail. (Major. | 172 9 | 16 49 | N | 1 19 | 34 N | | 173 28 | 16 15 |
| following lowest in ☐ Vrsa | 173 3 | 55 57 | N | 1 23 | 34 N | | 174 26 | 55 23 |
| Uppermost following in ☐. | 178 50 | 59 15 | N | 1 20 | 34 N | | 180 10 | 58 41 |
| Girdle ♍. | 188 53 | 5 37 | N | 1 18 | 34 N | | 190 11 | 5 3 |
| Rump Vrsa Major, Aliot. | 189 1 | 58 10 | N | 1 19 | 33 N | | 190 10 | 57 37 |
| Vindemiatrix, ♍. | 190 36 | 13 8 | N | 1 17 | 33 N | | 191 53 | 12 35 |
| Spica ♍. | 196 4 | 9 1 | S | 1 19½ | 32½ S | | 197 23½ | 9 33½ |
| Middle tail Vrsa Major. | 196 54 | 57 3 | N | 1 3 | 32 N | | 197 57 | 56 31 |
| End Tail Vrs. Major. | 202 54 | 51 22 | N | 1 2 | 31 N | | 203 56 | 50 51 |
| Arcturus. | 209 23½ | 21 18½ | N | 1 11 | 29½ N | | 210 34½ | 20 49 |
| Left Shelder of Bootes. | 214 2 | 40 3 | N | 1 2 | 27 N | | 215 4 | 39 36 |
| South Scale ♎. | 217 14½ | 14 18 | S | 1 23 | 27 S | | 218 37½ | 14 45 |
| North Scale ♎. | 223 54½ | 7 50 | S | 1 21½ | 24 S | | 225 16 | 8 14 |
| * Northern Crown. | 229 26 | 28 6 | N | 1 5 | 21 N | | 230 31 | 27 45 |
| * Serpents neck. | 231 12 | 7 46 | N | 1 15 | 21 N | | 232 27 | 7 25 |
| Northern of 3. * in front | 235 34 | 18 38 | S | 1 28 | 19 S | | 237 2 | 18 57 |
| Left hand Ophiucus. (m. | 238 25 | 2 37 | S | 1 23 | 18 S | | 239 48 | 2 55 |
| Heart m. Antares, | 241 18 | 25 26 | S | 1 32 | 16 S | | 242 50 | 25 42 |
| Right Shold. Hercules. | 243 15 | 22 27 | N | 1 5 | 15 N | | 244 20 | 22 12 |
| Left knee of Ophiucus. | 243 49 | 9 39 | S | 1 23 | 15 S | | 245 12 | 9 54 |
| Right knee of Ophiucus. | 251 50 | 15 7 | S | 0 50 | 10 S | | 252 40 | 15 17 |
| Head of Hercules. | 254 6 | 14 55 | N | 1 8 | 8 N | | 255 14 | 14 47 |
| Left Shelder of Hercules. | 254 40 | 25 22 | N | 0 52 | 8 N | | 255 32 | 25 14 |
| Head of Ophiucus. | 259 5 | 12 56 | N | 1 11 | 7 N | | 260 16 | 12 49 |
| Right Shelder of Ophiucus. | 260 56 | 4 49 | N | 1 13 | 5 N | | 262 9 | 4 44 |
| * head of the Dragon. | 266 52 | 51 37 | N | 0 35 | 2 N | | 267 27 | 51 35 |
| * Lyræ. | 275 52 | 38 28 | N | 0 50 | 4 S | | 276 42 | 38 32 |
| Most Eastern in Head ♐. | 281 32 | 21 35 | S | 1 31 | 8 N | | 283 3 | 21 27 |
| Vultures tail. | 281 47 | 13 20 | N | 1 13 | 8 S | | 283 0 | 13 28 |
| In the Swans Beak. | 288 40 | 27 10 | N | 1 1 | 11 S | | 289 41 | 27 24 |
| * in Vulture. | 292 49 | 7 54 | N | 1 17 | 13 S | | 294 6 | 8 7 |
| In the Swans North wing. | 293 10 | 44 12 | N | 0 48 | 14 N | | 293 58 | 44 26 |

| | 1660 | | | Differentia. | | | 1700 | | |
|---|---|---|---|---|---|---|---|---|---|
| *Names of the Stars.* | *R. Asc.* | *Declin* | | *R. Asc.* | *Decl.* | | *R Asc.* | *Declin.* | |
| *Upper horn* ♈. | 289 57 | 13 40 | *S* | 1 25 | 16 | *N* | 300 22 | 13 24 | |
| *Lower horn* ♈. | 299 39 | 15 57 | *S* | 1 27 | 17 | *N* | 301 6 | 15 40 | |
| *In the Swans breast.* | 302 1½ | 39 1 | *N* | 0 53½ | 18 | *S* | 302 55 | 39 19 | |
| *Left hand of* ♒. | 306 32 | 10 53 | *S* | 1 16 | 19 | *N* | 307 48 | 10 34 | |
| *Swans Tail.* | 306 57½ | 43 53½ | *N* | 0 51½ | 20½ | *S* | 307 49 | 44 14 | |
| *In the Swans South wing* | 307 31 | 32 30 | *N* | 1 0 | 21 | *S* | 308 31 | 32 51 | |
| *Left Sholder* ♒. | 317 37 | 7 15 | *S* | 1 21 | 26 | *N* | 318 58 | 6 49 | |
| 1. *In tail* ♈. | 319 28 | 18 21 | *S* | 1 26 | 26 | *N* | 320 54 | 17 55 | |
| *In Cepheus Girdle.* | 320 46 | 68 50 | *N* | 0 22 | 26 | *S* | 321 8 | 69 16 | |
| *In Pegasus mouth.* | 321 10 | 8 5 | *N* | 1 18 | 26 | *S* | 322 28 | 8 31 | |
| 2. *in tail* ♈. | 321 16 | 17 51 | *S* | 1 25 | 27 | *N* | 322 41 | 17 24 | |
| *Right Sholder of* ♒. | 326 19 | 2 13 | *S* | 1 20 | 29 | *N* | 327 39 | 1 44 | |
| Fomahant, ♒. | 338 46 | 31 39 | *S* | 1 25 | 31 | *N* | 340 11 | 31 8 | |
| Scheat. *Pegasus.* | 241 9 | 25 56 | *N* | 1 12 | 32 | *S* | 342 11 | 26 28 | |
| Marchab, *Pegasus.* | 341 15 | 13 5 | *N* | 1 15 | 32 | *S* | 342 30 | 13 37 | |
| *Mouth of Southern fish.* | 344 9 | 1 7 | *N* | 1 17 | 33 | *S* | 345 26 | 1 40 | |
| *Head of Andromeda.* | 356 59 | 26 54 | *N* | 1 17 | 34 | *S* | 358 16 | 27 28 | |
| * *Cassiopeæ's chair.* | 357 5 | 56 58 | *N* | 1 15 | 34 | *S* | 358 20 | 57 32 | |
| *End of Pegasus wing.(tail.* | 358 14 | 12 58 | *N* | 1 16 | 34 | *S* | 359 30 | 13 32 | |
| *Northern in the whales* | 359 49 | 11 1 | *S* | 1 18 | 34 | *S* | 1 7 | 10 27 | |

## *The Vse of this Table.*

The first Collumne on the left hand is the names of the Stars. The Second Collumne shews the degrees and minutes of *Right Ascension*, for the Year 1600. The third the *Declination* for the same Year. The fourth shews whether the Declination be *North* or *South*; N stands for *North*, S for *South*. The fifth shews the difference in degrees and minutes of *Right Ascension* of the Stars, between the Years 1600. and 1670. The sixth shews the Difference of *Declination*; and whether it be *North*, or *South*. The seventh shews the *Right Ascension* in degrees and minutes, for the Year 1670. The eighth shews the *Declination* in degrees and minutes for the same Year.

By this Table you may perceive the fixed Stars increase in Right Ascension, till they come to the *Vernal* Colure; from whence

whence the number of their Right Aſcenſion is reckoned: and by the Collumne of their Difference of Right Aſcenſion, you may ſee how much they increaſe in 70. Years, And if you would know how much they increaſe for any other number of Years, you muſt find what proportion they have to 70, and the ſame proportion the Difference of the Right Aſcenſion of the Stars will have to the Difference in the Table.

## Example.

I would know the Difference of Right Aſcenſion the *Pole-Star* will have in 35. Years. I find in the fifth Collumne the Difference of Right Aſcenſion of the *Pole Star* to be 3. degrees 59. min. Therefore by the Rule of Proportion, I ſay, If 70. Years give 3. degrees 59. min. 35. Years ſhall give 1. degree $59\frac{1}{2}$. min: and ſo proportionably for any other number of Years.

Though this Rule ſerves for finding the Difference of Right Aſcenſion of any Star; Yet it will not ſerve for finding the Difference of any Stars Declination. For the Stars on the North ſide the Equinoctial between the *Hyemnal* and *Solſticial* Colures, and on the South ſide the Equinoctial between the *Solſticial* and *Hyemnal* Colures, increaſe in Declination. But the Stars on the South ſide the Equinoctial between the *Hyemnal* and *Solſticial* Colures, and on the North ſide the Equinoctial between the *Solſticial* and *Hyemnal* Colures, Decreaſe in Declination: as you may yet more plainly ſee by the Globe, if you bring $66\frac{1}{2}$ deg. of the Meridian to the North ſide of the Horizon, and ſcrew the Quadrant of Altitude to $66\frac{1}{2}$ degrees in the *Zenith*, and Declination of the Pole of the *Ecliptick*; and bring the *Hyemnal* Colure to the Meridian; for ſo ſhall the Pole of the *Ecliptick* be joyned with the center of the Quadrant of Altitude, and the *Ecliptick* with the Horizon; and all the Circles that the ſeveral degrees on the Quadrant make in a Revolution from *Weſt* to *Eaſt* upon the Poles of the Ecliptick, repreſent the great Revolution of every Star that each degree on the Quadrant cuts. And thus demonſtratively will be repreſented the progreſs of the fixed Stars through every degree of Longitude, and by conſequence the alteration of their Right Aſcenſion, and Declination. For, Imagining that degree of the Quadrant

drant of Altitude to be the Star, which just reaches the Star; you may by turning about the Quadrant, see how Obliquely the Star (or the degree representing the Star) either moves about, or cuts the Equinoctial, and all Circles parallel to the Equinoctial; and thereby observe it sometimes to incline in motion to, and other times to decline in motion from the Equinoctial. But how long time it will be ere the Star inclines to, or declines from the Equinoctial, you may know by finding the distance of Longitude in degrees it hath from either the *Solsticial* or *Hyemnal* Colure; and with respecting the foregoing Rules in its Position, you may by the Table in Book 1, Chap. 3. Sect. 3. satisfie your self.

## Example.

The most Northerly Star in the *Girdle of Orion* doth yet decrease in Declination. But I would know how long it shall decrease; Therefore by the 32. Probleme, I find the Longitude of that Star to be for the Year 1670. 77. deg. 51. min. which subducted out of 90, (the distance of the Solsticial Colure from the Equinoctial,) leaves 12. 9, for the distance of that Star from the Solsticial Colure. Therefore by the Table aforesaid, I find what number of Years answers to the motion of 12. deg. 9. min. And because I cannot find exactly the same number of degrees and minutes in the Table, I take the number neerest to it; which is 14. degrees 10. minutes, and that is the motion of the Ecliptick in 1000. Years. But because this 14. degrees 10. minutes is 2. degrees 1. minute too much, I seek 2. degrees, 1. min. in the Table, and the number of Years against it I would subduct from the number of Years against 14. deg. 10. min. and the remainder would be the number of Years required: But 2. deg. 1. min. I cannot find neither, therefore I must take the number of degrees and minutes neerest to it, which is 2. deg. 50. min. and that yeelds 200. Years; which subducted out of 1000. leaves 800. Years. But because this is also too much by the motion of 49. min. Therefore I seek for 49. min. in the Table, and subduct the number of Years against it from 800. and the remainder would be the number of Years required. But 49. min. is not in the Table neither, Therefore I take the neerest to it, which is 51. min. and that yeelds 60. Years; which subducted out of 800. leaves 740. But this is likewise too much by

the

the motion of two min. Therefore I ſeek 2. min. in the Table, but cannot find it neerer then $2\frac{1}{2}$, and againſt it I find 3. Years, which 3. Years I ſubduct out of 740, and the Remainder is 737. the number in Years required. You may if you pleaſe for exactneſs, ſubduct for the $\frac{1}{2}$ min. 8. Moneths; ſo have you 736. Years 4. Moneths, for the Time that the moſt Northerly Star in the *Girdle of Orion* will decreaſe in Declination after the Year 1670. which will be till *An. Dom.* 2406. after which time it will increaſe in Declination for 12706. Years together, till it come to have 47. degrees 8. min. of Declination: at which time it will be in or very neer the place of the moſt Southerly Star of the *Southern Crown*; and that Star in its place.

And thus the Pole Star is now found to increaſe in Declination, and will yet this 421 Years: after which time it will decreaſe in Declination for 12706 Years together, till it come to be within 42. degrees 42. minutes of the Equinoctial, in the void ſpace now between *Draco* and *Lyra*; at which time *Lyra* will be almoſt as neer the Pole, as the Pole Star now is; and then the moſt proper to be the Northern Pole Star: And the laſt Star in the *Stalk of the Doves mouth* will be then very neer the Southern Pole, and therefore moſt fit to be the Southern Pole-Star.

## Prob. XXVIII.

*The Place of the Sun or any Star given, to find the Right Deſcenſion, and the Oblique Aſcenſion, and the Oblique Deſcenſion.*

Bring the Place of the Sun or the Star to the Meridian under the Horizon, and the degree of the Equator that comes to the Meridian with it is the Degree of Right Deſcenſion.

### For the Oblique Aſcenſion.

Bring the Place of the Sun or the Star to the Eaſt ſide the Horizon, and the degree of the Equator cut by the Horizon, is the Degree of Oblique Aſcenſion of the Sun or Star.

For

## For the Oblique Descension.

Bring the Place of the Sun or Star to the West side the Horizon, and the degree of the Equinoctial cut by the Horizon is the Degree of Oblique Descension. They need no Examples.

## PROB. XXIX.

*Any Place on the Terrestrial Globe being given, to find its* Antipodes.

BRing the given Place to the Meridian, so may you (as by the first Probleme) see its Longitude and Latitude; then turn about the Globe till 180. degrees of the Equator pass through the Meridian; and keeping the Globe to this Position, number on the Meridian 180. degrees from the Latitude of the given Place: and the point just under that degree is the *Antipodes*.

### Example.

I would find the *Antipodes* of *Cuida Real*, an Inland Town of the *West Indies*, which lies upon the River *Parana*, an Arm of *Rio de la Plata*: Therefore I bring *Cuida Real* to the Meridian, and find (as by the first Probleme) its Latitude 23. 50. South; and its Longitude 333. degrees: Then I turn about the Globe till 180. degrees of the Equator pass through the Meridian; and keeping the Globe to that position, I number so many degrees North Latitude as *Parana* hath South, *viz.* 23, 50. and just under that degree I find *Lamoo*, a Town lying upon the Coast of *China*, in the Province of *Quancij*: Therefore I say *Lamoo* is just the *Antipodes* of *Cuida Real*.

### Another way.

Bring the given Place to the North or South point of the Horizon, and the point of the Globe denoted by the opposite point of the Horizon, is the *Antipodes* of the given Place.

PROB.

## Prob. XXX.

*To find the* Perecij *of any given Place, by the Terreſtrial Globe.*

BRing your Place to that ſide the Meridian which is in the South notch of the Horizon, and follow the Parallel of that Place on the Globe till you come to that ſide the Meridian which is in the Northern notch of the Horizon; and that is the *Perecij* of your Place.

## Prob. XXXI.

*To find the* Antecij *of any given Place, upon the Terreſtrial Globe.*

BRing your Place to the Meridian, and find its Latitude by the firſt Probleme; If it have North Latitude, count the ſame number of degrees on the Meridian from the Equator Southwards; But if it have South Latitude, count the ſame number of degrees from the Equator Northwards: and the point of the Globe directly under that number of degrees is the *Antecij* of your Place.

## Prob. XXXII.

*To find the Longitude and Latitude of the Stars, by the Cœleſtial Globe.*

THe Quadrant of Altitude will reach but 90. degrees, as was ſaid Prob. 9. Therefore if the Star you enquire after be on the North ſide the Ecliptick, you muſt elevate the North Pole $66\frac{1}{2}$ degrees above the North ſide the Horizon: If on the South ſide the Ecliptick, you muſt elevate the South Nole $66\frac{1}{2}$ degrees above the South ſide the Horizon: Then bring the *Solſticial Colure* to the Meridian on the North ſide the Horizon, and ſcrew the Quadrant of altitude to the *Zenith*, which will be in $23\frac{1}{2}$ degrees from the Pole of the World: So ſhall the Ecliptick ly in the Horizon, and the Pole of the Ecliptick alſo ly under the Center of the Quadrant of Altitude (as was

ſhewed Prob. 27.) Now to find the Longitude of any Star, do thus Turn the Quadrant of Altitude about till the graduated edge of it ly on the Star; and the degree in the *Ecliptick* that the Quadrant touches is the Longitude of that Star.

### Example, for a Star on the North ſide the *Ecliptick*.

I would know the Longitude of *Marchab*, a bright Star in the wing of *Pegaſus*: I find it on the North ſide the *Ecliptick*, Therefore I elevate the North Pole, and placing ♋ on the North ſide the Meridian, I ſcrew the Quadrant of Altitude to the *Zenith*, as aforeſaid: Then laying the edge of the Quadrant of Altitude upon that Star, I find that the end of it reaches in the *Ecliptick* to ♓ 18. 56. Therefore I ſay, the Longitude of *Marchab* is ♓. 18. 56.

### For the Latitude of a Star.

The Degree of the Quadrant of Altitude that touches the Star is the Latitude of the Star.

### Example.

The Globe and Quadrant poſited as before, I find 19. deg. 26. min. (accounted upwards on the Quadrant) to touch *Marchab* aforeſaid: Therefore I ſay, the Latitude of *Marchab* is 19. deg. 26. min.

And thus by elevating the South Pole and placing the Globe and Quadrant of Altitude as aforeſaid, I ſhall find *Canicula* have 15. degrees 57. min. South Latitude, and 21. degr. 18. min in ♋, Longitude.

## Prob. XXXIII.

*To find the Diſtance between any two Places, on the Terreſtrial Globe.*

THis may be performed either with the Quadrant of Altitude, or with a pair of Compaſſes: with the Quadrant of Altitude, thus: Lay the lower end thereof to one Place, and ſee what degree reaches the other Place, for that

that is the number of degrees between the two Places. If you multiply that number of Degrees by 60. the Product ſhall be the number of Engliſh Miles between the two Places.

## Example.

I would know the diſtance between *London* and the moſt Eaſterly point of *Jamaica*; I lay the lower end of the Quadrant of Altitude to *Jamaica*, and extending the other end towards *London*, I find $68\frac{1}{2}$ deg. comprehended between them: Therefore I ſay $68\frac{1}{2}$ is the number of degrees comprehended between *London* and *Jamaica*.

If you would find the Diſtance between them with your Compaſſes, you muſt pitch one foot of your Compaſſes in the Eaſt point of *Jamaica*, and open your Compaſſes till the other foot reach *London*; and keeping your Compaſſes at that Diſtance, apply the feet to the Equinoctial line, and you wil find $68\frac{1}{2}$ degree comprehended between them: as before.

If you multiply $68\frac{1}{2}$ by 60, is it gives 4110. *Engliſh* miles.
If you multiply it by 20, it gives 1370. *Engliſh* Leagues.
If you multiply it by $17\frac{1}{2}$, it gives 1199. *Spaniſh* Leagues.
If you multiply it by 15, it gives 1054 *Dutch* Leagues.

## Prob. XXXIV.

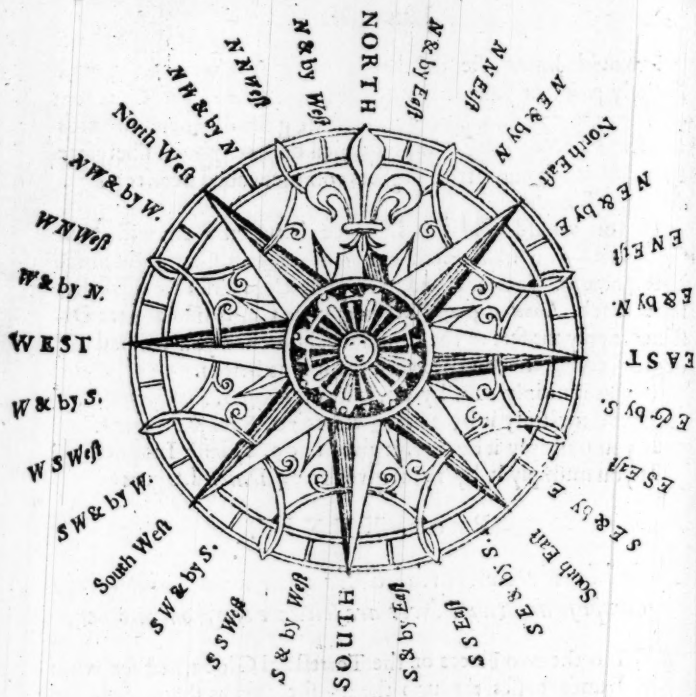
*To find by the Terreſtrial Globe upon what point of the Compaſs any two Places are ſcituate one from another.*

FInd the two Places on the Terreſtrial Globe, and ſee what Rumb paſſes through them; for that is the point of the Compaſs they bear upon.

## Example.

*Briſtol* and *Bermudas* are the Places: I examine what Rhumb paſſes through them both: and becauſe I find no Rhumb to paſs immediately through them both, Therefore I take that Rhumb which runs moſt Parallel to both the Places; which in this Example is the tenth Rhumb counted from the North towards the left hand; and is called as you may ſee by this following

Figure *Weſt South Weſt*; Therefore I ſay *Bermudos* lies ſcituate from *Briſtol Weſt South Weſt*; and by contraries *Briſtol* lies cituate from *Bermudos Eaſt North Eaſt*.




## PROB. XXXV.

*To find by the Cœleſtial Globe the* Coſmical Riſing *and* Setting *of the Stars.*

WHen any Star Riſes with the Sun, it is ſaid to Riſe *Coſmically*.

And when any Star Sets when the Sun Riſes, it is ſaid to Set *Coſmically*.

To find theſe, Rectifie the Globe to the Latitude of your Place,

Place, and bring the Place of the Sun to the East side the Horizon; and the Stars then cut by the Eastern Semi-Circle of the Horizon, Rise *Cosmically*; and those Stars cut by the Western Semi-Circle of the Horizon, Set *Cosmically*.

## Example.

*Novemb.* 9. I would know what Stars Rise and Set *Cosmically*, here at *London*. The Suns Place found, as by the third Probleme is ♏ 27. Therefore I bring ♏ 27. to the East side the Horizon, and in the Eastern Semi-Circle I find Rising with the Sun the right *Wing* of *Cygnus*, the Star in the end of *Aquila's tail*, *Serpentarius* and *Centaurus*: Therefore these Constellations are said to rise *Cosmically*. In the Western Semi-Circle of the Horizon I find Setting *Andromeda*, the *Triangle*, *Taurus*, *Orion*, *Canis Major*, and *Argo Navis*; Therefore I say, these Constellations Set *Cosmically*.

## Prob. XXXVI.

### *To find by the Cœlestial Globe the* Acronical *Rising and Setting of the Stars.*

The Stars that Rise when the Sun Sets, are said to Rise *Acronically*. And,

The Stars that Set with the Sun, are said to Set *Acronically*.

To find these, Rectifie the Globe to the Latitude of your Place, and bring the Place of the Sun to the West side the Horizon; and the Stars then cut by the Eastern Semi-Circle of the Horizon, Rise *Acronically*: And those Stars cut by the Western Semi-Circle of the Horizon, Set *Acronically*.

## Example.

*November* 9. I would know what Stars Rise and Set *Acronically* here at *London*. The Suns Place as before, is ♏ 27. Therefore I bring ♏ 27. to the West side the Horizon; and in the Eastern Semi-Circle I find Rising the *Southern Fish*, *Fomahant*, *Cetus*, *Taurus*, *Auriga*, and the *Feather* in *Castor's Cap*. Therefore these Constellations are said to Rise *Acronically*. In

the Western Semi-Circle of the Horizon I find Setting the *Lyons tail, Virgo, Scorpio, and Sagittarius*, Therefore I say, these Constellations Set *Acronically*.

## Prob. XXXVII.

### *To find by the Cœlestial Globe the* Heliacal Rising, *and* Setting *of the Stars.*

When a Star formerly in the Suns Beams gets out of the Suns Beams, it is said to *Rise Heliacally*. And

When a Star formerly out of the Suns Beams, gets into the Suns Beams, it is said to *set Heliacally*.

A Star is said to be in the Suns Beams, when it is made inconspicuous by reason of its neerness to the Suns Light. The Bigger Stars are discernable more neer the Suns Light, then the Lesser are: For, Stars of the first Magnitude may (according to the received Rules of ancient Authors) be seen when the Sun is but 12. degrees below the Horizon but Stars of Second Magnitude cannot be seen unless the Sun be 13. degrees below the Horizon: Stars of the third Magnitude require the Sun to be 14. degrees below the Horizon, ere they can be seen; of the fourth Magnitude 15. degrees. of the fifth Magnitude 16. degrees of the sixth Magnitude 17 degrees; the Nebulous ones 18. degrees. Yet this Rule is not so certain but that either clear or cloudy weather may alter it. Read more of this subject in Mr *Palmer* on the *Planisphear*. Book 4. Chap. 20.

Now to find the Time that any Star shall Rise Heliacally. Do thus Rectifie the Globe and Quadrant of Altitude to your Latitude. Then bring the given Star to the East side the Horizon, and turn the Quadrant of Altitude into the West side. and see what degree of the *Ecliptick* is elevated so many degrees above the Horizon as the Magnitude of the Star you enquire after requires, according to the foregoing Rules; for the opposite degree of the *Ecliptick* is the degree the Sun shall be in when that Star Rises *Heliacally*. Having the degree of the *Ecliptick* the Sun is in, you may find the Day of the Moneth, by the 4th Probleme.

Exam-

## Example.

I would know when *Cor Leonis* ſhall Riſe *Heliacally* here at *London*: Therefore I Rectifie the Globe and Quadrant of Altitude for *London*, and bring *Cor Leonis* to the Eaſt ſide the Horizon, and turn the Quadrant of Altitude into the Weſt; and becauſe *Cor Leonis* is a Star of the firſt Magnitude, therefore I ſee what degree of the *Ecliptick* is elevated in the Weſt ſide the Horizon 12. degrees on the Quadrant of Altitude, and find ♓ 9. deg. Now the degree of the *Ecliptick* oppoſite to ♓ 9. is ♍ 9. Therefore I ſay, when the Sun comes to ♍ 9. degrees (which by the 4th Probleme I find is *Auguſt.* 23.) *Cor Leonis* ſhall *Riſe Heliacally.*

## For the *Heliacal Setting.*

The Globe, &c. Rectified, as before: Bring the Star to the Weſt ſide the Horizon, Then ſee what degree of the *Ecliptick* is elevated on the Quadrant of Altitude ſo many degrees as the Stars Magnitude requires; for when the Sun comes to the oppoſite degree of the *Ecliptick* that Star ſhall *ſet Heliacally.*

## Example.

I would know when *Bilanx* a Star in the *Beam* of the *Scales*, will *Set Heliacally* here at *London.* The Globe and Quadrant Rectified, I bring *Bilanx* to the Weſt ſide the Horizon, and turn the Quadrant of Altitude into the Eaſt; Then I examine what degree of the *Ecliptick* is elevated 13. degrees of the Quadrant of Altitude (becauſe *Bilanx* is a Star of the ſecond Magnitude) and find ♉ $4\frac{1}{2}$. oppoſite to ♉ $4\frac{1}{2}$. is ♏ $4\frac{1}{2}$. Therefore I ſay, When the Sun comes to ♏ $4\frac{1}{2}$. (which by Probleme 4. will be *October* 18) *Bilanx* ſhall ſet *Heliacally.*

## Prob. XXXVIII.

*To find the Diurnal and Nocturnal Arch of the Sun, or Stars, in any given Latitude.*

The Semi-Diurnal Arch is the number of degrees of the Equator that paſſes through the Meridian whiles the Sun or any

any Star is ascending above the East side the Horizon to the Meridian. To know the number of degrees it contains, Rectifie the Globe to the given Latitude, and bring the Place of the Sun or Star to the East side the Horizon, and note what number of degrees of the Equinoctial is then cut by the Meridian: Then remove the Place of the Sun or Star to the Meridian, and see again what number of degrees of the Equinoctial is then cut by the Meridian, and substract the former from the latter, and the remainder shall be the number of degrees of the Sun or Stars Semi-Diurnal Arch. But Note, If the Equinoctial point ♈ pass through the Meridian while the Sun or Star is turned from the East side the Horizon to the Meridian, then you must substract the number of degrees of the Equinoctial cut by the Meridian when the Sun or Star is at the East side the Horizon from 360. degrees, and to the remainder ad the number of degrees of the Equinoctial that comes to the Meridian with the Place of the Sun or Star, and the Sum of them both is the number of degrees of the Sun or Stars Semi-diurnal Arch; which being doubled is the number of degrees of the whole Diurnal Arch: and which being substracted from 360. gives the Nocturnal Arch.

## Example, of the Sun.

Having Rectified the Globe, I would *May* 10. know the Diurnal Arch of the Sun: His Place found by *Prob.* 3. is ♉ 29. Therefore I bring ♉ 29. to the East side the Horizon, and find then at the Meridian 299. degrees 30. min. of the Equinoctial; then I turn the Place of the Sun to the Meridian, and find 56. deg. 30. min. of the Equinoctial come to the Meridian with it. Here the Equinoctial point ♈ passes through the Meridian while the Sun moves between the Horizon and the Meridian; Therefore as aforesaid, I substract the first number of degrees and minutes *viz.* 299. deg. 30. min. from 360. degrees, and there remains 60. degr. 30. min. for the number of degrees and minutes contained between the degree of the Equinoctial at the Meridian and the Equinoctial point ♈; and to this 60. deg. 30. min. I ad the second number of degrees and minutes. *viz.* 56. deg. 30. min. the number of degrees and minutes between the point ♈ and the deg. of the Equinoctial at the Meridian, and they make together 117. degrees, for the Suns Semi diurnal Arch:

Arch: By doubling of which, you have 234. degrees, for the Suns Diurnal Arch; And by ſubſtracting 234. (the Diurnal Arch) from 360. you have 126. degrees, for the Suns Nocturnal Arch.

### Example, for a Star.

I take *Sirius*, a bright Star in the *Great Dogs mouth*. The Globe rectified, as before; I bring *Sirius* to the Eaſt ſide the Horizon, and find then 29. degrees 30 minutes of the Equinoctial at the Meridian, then I turn *Sirius* to the Meridian and find 97. degrees 38 minutes of the Equinoctial come to the Meridian with it: Therefore I ſubſtract the firſt number *viz.* 29. degrees 30. minutes, from the ſecond, 97. 38. and the remains is 68. degrees 8 minutes, for the Semi-diurnal Arch of *Sirius*.

His Nocturnal Arch you may find as before.

## Prob. XXXIX.

### *To find the* Azimuth *and* Almicantar *of any Star.*

THis Probleme is like the 22, and 23. Problemes, which ſhew the finding the *Azimuth* and *Almicantar* of the Sun; only, whereas there you were directed to bring the degree of the Sun to the Quadrant of Altitude, you muſt now bring the Star propoſed to the Quadrant of Altitude; and by the Directions in thoſe Problemes the reſolution will be found.

## Prob. XL.

### *To find the* Hour *of the* Night, *by obſerving two known Stars in one* Azimuth, *or* Almicantar.

REctifie the Globe Quadrant and Hour Index. Then find the two known Stars on the Globe; and if the two Stars be in one *Azimuth*, turn about the Globe and Quadrant of Altitude till you can fit the two Stars to ly under the graduated edge of the Quadrant of Altitude: ſo ſhall the Index of the Hour-Circle point at the Hour of the Night. If

the two Stars be in one *Almicantar*, Turn the Globe forward or backward till the two Stars come to ſuch a Poſition that by moving the Quadrant of Altitude, the ſame degree on it will ly on both the Stars; ſo ſhall the Index of the Hour-Circle point at the Hour of the Night.

## Prob. XLI.

*The* Hour *given that any Star in Heaven comes to the Meridian, to know thereby the Place of the Sun, and by conſequence the* Day *of the Moneth, though it were loſt.*

Bring the Star propoſed to the Meridian, and turn the Index of the Hour-Circle to the Hour given, Then turn about the Globe till the Index point at the Hour of 12. for Noon; and the Place of the Sun in the *Ecliptick* ſhall be cut by the Meridian.

### Example.

*March 7.* at 11. aclock at Night the *Pointers* come to the Meridian of *London.* Therefore I place the *Pointers* on the *Celeſtial* Globe under the Meridian, and turn the Index of the Hour-Circle to 11. paſt Noon, afterwards I turn back the Globe till the Index point to 12. at Noon; Then looking in the *Ecliptick*, I find the Meridian cuts it in ♈ 26. 45. minutes; Therefore I ſay, when the *Pointers* come to the Meridian at 11. a clock at Night, the Place of the Sun is ♈ 26. 45. Having thus the Place of the Sun, I may find the Day of the Moneth by the fourth Probleme; and ſo either know the Day that the *Pointers* come to the Meridian at 11. a clock at Night, or at any other Hour given.

The Day of the Moneth might alſo be found by the Declination and the Quarter of the *Ecliptick* the Sun is in, given: For the Meridian will cut the degree of the Suns Place in the *Ecliptick* in the Parallel of Declination: So that having reſpect to the Quarter of the *Ecliptick*, you'le find the Suns Place; and having the Suns Place, you may as aforeſaid find the Day of the Moneth.

Prob.

## PROB. XLII.

### *The Day of the Moneth given, to find in the Circle of Letters on the Plain of the Horizon, the Day of the Week.*

THE seven Daies of the Week were by the Idolatry of the ancient Roman Heathenish Times Dedicated to the Honour of seven of their Gods, which we call *Planets*. The first is the most eminent, and therefore doubtless by them set in the first Place, called *Dia Solis*, or the Suns Day: The second *Dia Lunæ*, the Moons Day: The third *Dia Martis*, the Day of *Mars*: by us called *Tuesday*: The fourth *Dia Mercurius*, *Mercuries* Day: by us called *Wednesday*; from *Woden*, an Idol the *Saxons* Worshipt, to whose Honour they Dedicated that Day, and is by all those *Germain* Nations still called *Wodensdagh*: The fifth *Dia Jovis*, *Jupiter* or *Joves* Day: which doubtless the *Saxons* (from whom probably we receive it) called *Donder-dagh*, because *Jupiter* is the God of Thunder; and we either by corruption or for shortness, or both, call it *Thursday*: The sixth *Dia Veneris*, the Day of *Venus*: but the *Saxons* transferring her Honour to another of their Goddesses named *Fria*, called it *Fridagh*: and we from them call it *Fryday*: The seventh is *Dia Saturnis*, *Saturus* Day.

The same Day of the Moneth in other Years happens not on the same Day of the Week, therefore the Dominical Letter for one Year is not the same it is the next: Now because you cannot come to the knowledge of the Day of the Week unless you first know the Sundaies Letter, therefore have I in Prob. 5 inserted a Table of Mr *Palmers*, by which you may find the Dominical or Sundaies Letter for ever; and having the Dominical Letter you may in the Circle of Letters on the Horizon find it neer the day of that Moneth, and count that for *Sunday*, the next under it for *Monday*, the next under that for *Tuesday*, and so in order, till you come to the Day of the Moneth.

### Example.

I would know what Day of the Week *June* 1. *Anno* 1658. Old Style, falls on; I find by the Table aforesaid the Dominical

Letter is C, then I look in the Calender of Old Style for *June* 1. and againſt it I find Letter E, which becauſe it is the ſecond Letter in order from C, therefore it is the ſecond Day in order from *Sunday*, which is *Tueſday*.

## Prob. XLIII.

### *The* Azimuth *of any Star given, to find its* Hour *in any given* Latitude.

THe Hour of a Star is the number of Hours that a Star is diſtant from the Meridian. To find which, Rectifie the Globe and Quadrant of Altitude, and bring the Star propoſed to the Meridian, and the Index of the Hour-Circle to 12. Then place the lower end of the Quadrant of Altitude to the given *Azimuth* in the Horizon, and turn the Globe till the Star come to the graduated edge of the Quadrant of Altitude; ſo ſhall the Index of the Hour-Circle point at the Hour of the Star. Only this caution you muſt take; If the Star were turned from the Meridian towards the Eaſtern ſide of the Horizon, you muſt ſubſtract the number of Hours the Index points at from 12. and the remainder ſhall be the Hour of the Star. But if the Star were turned from the Meridian towards the Weſt ſide the Horizon, the Hour the Index points at is (without more adoe) the Hour of the Star.

## Prob. XLIV.

### *How you may learn to know all the Stars in Heaven, by the* Cœleſtial Globe.

REctifie the Globe, Quadrant, Hour-Index and Horizon, as by Prob. 2. Then turn about the Globe till the Index of the Hour-Circle point at the Hour of the Night on the Hour-Circle. Then if every Star on the Globe had a hole in the midſt, and your Ey were placed in the Center of the Globe; you might by keeping your Ey in the Center and looking through any Star on the Globe ſee its Match in Heaven: that is, the ſame Star in Heaven which that Star on the Globe repreſents: for from the Center of the Globe there proceeds a ſtraight line

line through the Star on the Globe, even to the ſame Star in Heaven. Therefore thoſe Stars that are in the *Zenith* in Heaven, will then be in the *Zenith* on the Globe; thoſe that are in the Eaſt in Heaven, will be in the Eaſt on the Globe; thoſe in the Weſt in Heaven, in the Weſt on the Globe; and thoſe Stars that are in any Altitude in Heaven, will at the ſame time have the ſame Altitude on the Globe; So that if you ſee any Star in Heaven whoſe Name you deſire to know, you need but obſerve its *Azimuth* and Altitude, and in the ſame *Azimuth* and Altitude on the Globe, you may find the ſame Star: and if it be an eminent Star, you will find its Name adjoyned to it.

## Example.

*December* 10. at half an hour paſt 9. a clock at Night, here at *London*, I ſee two bright Stars at a pretty diſtance one from another in the South; I deſire to know the Names of them; Therefore having the Globe rectified to the Latitude of *London*, and the Quadrant of Altitude ſcrewed to the *Zenith*, the Hour-Index alſo Rectified, and the Horizon poſited Horizontally, as by Prob. 2, I obſerve the Altitude of thoſe Stars in Heaven, (either with a Quadrant, Aſtrolabe, Croſs-ſtaff, or the Globe it ſelf, as hath been ſhewed Prob. 13, 16.) to be, the one 78. degrees, the other 42. degrees above the Horizon. Therefore having their Altitudes, I count the ſame number of degrees as for the firſt 78. upon the Quadrant of Altitude upwards, and turn it into the South, under the Meridian, and ſee what Star is under 78. degrees, for that is the ſame Star on the Globe which I ſaw in Heaven. Now at the firſt examination of the Globe you may ſee that that Star is placed in the Ey of that Aſteriſme which is called *Caput Meduſa*, and indeed, that being the only Star of Note in that Conſtellation, bears the Name of the whole Conſtellation. The other Stars about it you may eaſily know by their Scituation. As, Seeing two little Stars to the Weſtwards of that Star in Heaven, you may ſee on the Globe that the hithermoſt is in the other Ey of *Caput Meduſa*, and the furthermoſt in the *Hair* or *Snakes* of the ſame Aſteriſme. Looking a little to the Southwards of thoſe Stars in Heaven, you may ſee two other ſmal Stars a little below thoſe in the *Eyes*; Therefore to know thoſe alſo, you may look on the Globe, and ſee that there is one on the

*Nose*, and another Starre in the *Cheek* of *Caput Medusæ*

In like manner for the second Star in the Meridian, which is 42 degrees above the Horizon: If you move the Quadrant of Altitude (as before) to the South or Meridian, and count 42 degrees upon the Quadrant of Altitude, you will find a Star of the second Magnitude in the *Mouth* of the *Whale*: Therefore you may say, that Star in Heaven is in the *Mouth* of the *Whale*: and because close to it on the Globe is written *Menkar*, Therefore you may know the name of that Star in Heaven is *Menkar*.

In the South East and by South 56 degrees above the Horizon, I see a very bright Star in Heaven; therefore I bring the Quadrant of Altitude to the South East and by South point in the Horizon, and find under 56 degrees of the Quadrant of Altitude a great Star, to which is prefixed the name *Oculus Taurus*; Therefore I say, the name of that Star in Heaven is *Oculus Taurus*.

In the South East in Heaven you may see three bright Stars ly directly in a straight line from one another, the middlemost whereof is 25. degrees or thereabouts above the Horizon, therefore bring the Quadrant of Altitude to the South East point of the Horizon, and about 25 degrees above the Horizon you will see the same great Stars on the Globe, in the *Girdle* of *Orion*: Therefore those Stars are called *Orions Girdle*.

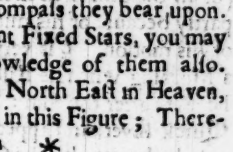
At the same time South East and by East you have about 10 degrees above the Horizon the brightest Star in Heaven, called *Sirius*, in the *Mouth* of the *Great Dog*; *Canicula* a bright Star in the *Little Dog* East and by South, about 25 degrees above the Horizon: *Cor Leonis* just Rising East North East: you have also at the same time on the East side the Horizon, the *Twins*, *Auriga*, the *Great Bear*; and divers other Stars, eminent both for their splendor and Magnitude.

In the West side the Horizon you have South West and by West about 4 degrees above the Horizon a bright Star in the *Right Leg* of *Aquarius*: and all along to the Southwards in *Cetus* the *Whale*, you have other eminent bright Stars: More upwards towards the *Zenith* you have a bright Star in the *Line* of the two *Fishes*: Higher yet, you have the first Star in ♈, an eminent Star, because the first in all Catalogues that we have cognizance of; and therefore probably in the Equinoctial Colure when the Stars were first reduced into Constellations: yet more

neer

neer the *Zenith* you have a bright Star in the *Left Leg* of *Andromeda*: From thence towards the North, you find other very eminent bright Stars in *Caſſiopea*, *Cepheus*, *Urſa Minor*, in the Tail whereof is the *Pole Star*: and *Draco*: *Hecules*: where you turn back, to *Lyra*, *Cygnus*, *Pegaſus*, the *Dolphin*, &c. all which, or any other, you may eaſily know by their Altitude above the Horizon, and the point of the Compaſs they bear upon.

Thus knowing ſome of the moſt eminent Fixed Stars, you may by the Figure of the reſt come to the knowledge of them alſo. For Example, Looking towards the North North Eaſt in Heaven, you may ſee ſeven bright Stars conſtituted in this Figure; Therefore looking towards the ſame Quarter on the Globe, you may (without taking their Altitude) ſee the ſame Stars lying in the ſame Figure in the hinder parts of the *Great Bear*; from whence you may conclude, that thoſe Stars in Heaven are ſcituate in the hinder parts of the Aſteriſme called *Urſa Major*.



Yet nevertheleſs you may ſee ſome Stars of Note in Heaven, which you ſhall not find on the Globe, and thoſe in or neer about the Ecliptick: They are called *Planets*, and cannot be placed on the Globe, unleſs it be for a particular Time, with Black Lead, or ſome ſuch thing that may be rubbed out again: Becauſe they having a continual motion alwaies alter their Places. Of thoſe there are five in number, beſides the *Sun* and *Moon*, which are alſo Planets, though they ſhew not like Stars. Theſe five are called *Saturn*, *Jupiter*, *Mars*, *Venus*, *Mercury*; yet *Mecury* is very rarely ſeen: becauſe he never Riſing above an Hour before the Sun, or Setting above a Hour after, for the moſt part hath his light ſo overſpread with the dazelling Beams of the glittering Sun, that ſometimes when he is ſeen he ſeems rather to be a Mote in the Suns Beams, then a Body endowed with ſo much brightneſs as Stars and Planets ſeem to be.

Now there are divers waies (by ſome of which you may at all times) know thoſe Planets from the Fixed Stars: as firſt, Their not twinkling, for therein they differ from fixed Stars; becauſe they moſt commonly do twinkle, but Planets never; unleſs it be ♂ *Mars*; and yet he twinkles but very ſeldom neither.

Secondly, They appear of a conſiderable Magnitude, as ♃ ſome-

sometimes appears greater by far then a Star of the first Magnitude; and ♀ many times bigger then he. They are both glittering Stars, of a bright Silver colloure: but ♀ most radient, especially when she is in her *Perigeon*. ♂ appears like a Star of the second Magnitude; and is of a Copperish colloure. ♄ shewes like a Star of the third Magnitude, and is of a Leaden Collour; and he (of all the others,) is most difficult to be known from a fixed Star; partly because of his minority, and partly because of the slowness of his motion. ☿ is very seldom seen (as aforesaid) unless it be in a Morning when he Rises before the Sun, or in an Evening when he Sets after the Sun: He is of a Pale Whitish Collour, like Quick-silver, and appears like a Star of the third Magnitude. He may be known by the Company he keeps, for he is never above 29. degrees distant from the Sun.

Thirdly, The Planets may be known from fixed Stars by their Azimuths and Altitudes observed: (as hath been taught before) for if when you have taken the Azimuth and Altitude of the Star in Heaven you doubt to be a Planet, and you find not on the Globe in the same Azimuth and Altitude a Star appearing to be of the same Magnitude that that in Heaven appears to be, you may conclude that that in Heaven is a Planet. Yet notwithstanding it may happen that a Planet may be in the same degree of Longitude and Latitude in the Zodiack that some eminent fixed Star is in; as in the degree and minute of Longitude and Latitude that *Cor Leonis*, or the *Bulls Ey*, or *Scorpions heart* is in, and so may eclipse that Star, by being placed between us and it: But that happens very seldom and rarely; but if you doubt it, you may apply your self to some other of the precedent and subsequent Rules here set down for knowing Planets from fixed Stars.

The fourth way is by shifting their Places; for the Planets having a continual motion, do continually alter their Places: as ♂ moves about half a degree in a day: ♀ a whole degree; but ♃ and ♄ move very slowly; ♃ not moving above 5. minutes, and ♄ seldom above 2. minutes. Yet by their motions alone the Planets may be known to be Planets, if you will precisely observe their distance from any known fixed Star in or near the Ecliptick as on this Night, and the next Night after observe whether they retain the same distance they had the Night before; which if they do, then are they fixed Stars; but if they do not, then are they Planets: yet this Caution is to be given you in this Rule also,

That

That the Planets ſometimes are ſaid to be *Stationary*, as not altering 1. minute in Place, forwards, or backwards in 6. or 7. daies together. Therefore, if you find cauſe to doubt whether your Star be a Planet, or a fixed Star, you may for the help of your underſtanding confer with ſome of the former Rules, unleſs you are willing to wait 8 or 9 daies longer, and ſo by obſervation of its motion reſolve your ſelf. Or,

Fifthly, you may apply your ſelf to an *Ephemeris* for that Year, and ſee if on that day you find any Planet in the degree and minute of the Zodiack you ſee the Star you queſtion in Heaven; and if there be no Planet in that degree of the Zodiack, you may conclude it is no Planet, but a fixed Star.

## Prob. XLV.

*How to hang the Terreſtrial Globe in ſuch a poſition that by the Suns ſhining upon it you may with great delight at once behold the demonſtration of many Principles in* Aſtronomy, *and* Geography.

TAke the Terreſtrial Ball out of the Horizon, and faſten a thred on the Brazen Meridian to the degree of the Latitude of your Place; by this thred hang the Globe in a place where the Suns Beams may have a free acceſs to it; Then direct the Poles of the Globe to their proper Poles in Heaven, the North Pole to the North, and the South Pole to the South; and with a thred faſtned to either Pole, brace the Globe, ſo, that it do not turn from his poſition: then bring your Habitation to the Meridian; ſo ſhall your Terreſtrial Globe be Rectified to correſpond in all reſpects with the Earth it ſelf; even as in Prob. 44. the Celeſtial Globe doth; the Poles of the Globe, to the Poles of the World; the Meridian of the Globe, to the Meridian of the World; and the ſeveral Regions on the Globe made Correſpondent to the ſame Regions on the Earth: So that with great delight you may behold,

1. How the counterfeit Earth (like the true one) will have one Hemiſphear Sun ſhine light, and the other ſhadowed, and as it were dark. By the ſhining Hemiſphear you may ſee that it is Day in all Places that are ſcituate under it; for on them the Sun doth ſhine; and that it is Night at the ſame time in thoſe Places

that are ſituate in the ſhadowed Hemiſphear; for on them the Sun doth not ſhine; and therefore they remain in darkneſs.

2. If in the middle of the enlightned Hemiſphear you ſet a Spherick Gnomon Perpendicularly, it will project no ſhadow, but ſhews that the Sun is juſt in the Zenith of that Place; that is, directly over the heads of the Inhabitants of that Place: and the point that the Spherick Gnomon ſtands on, being removed to the Meridian, ſhews the Declination of the Sun on the Meridian for that Day.

3. If you draw a Meridian line from one Pole to the other, in all Places under that line, it is Noon: in thoſe Places ſcituate to the Weſt, it is Morning; for with them the Sun is Eaſt: and in thoſe Places ſcituate to the Eaſt, it is Evening; for with them the Sun is Weſt.

4. Note the degree of the Equator where the enlightned Hemiſphear is parted from the ſhadowed; for the number of degrees of the Equator intercepted between that degree and the Meridian of any Place, converted into Hours (by accounting for every 15. degrees 1. Hour) ſhews, if the Sun be Eaſtwards of that Place, how long it will be ere the Sun Riſes, Sets, or comes to the Meridian of that Place: or if the Sun be Weſtward of that Place, how long it is ſince the Sun Roſe, or Set, or was at the Meridian of that Place.

5. The Inhabitants of all Places between the enlightned and ſhadowed Hemiſphear, behold the Sun in the Horizon: Thoſe Weſtwards of the Meridian Semi-Circle drawn through the middle of the enlightned Hemiſphear behold the Sun Riſing: Thoſe in the Eaſt, ſee it Setting.

6. So many degrees as the Sun reaches beyond either the North or South Pole, ſo many degrees is the Declination of the Sun, either Northwards or Southwards: and in all thoſe Places comprehended in a Circle deſcribed at the termination of the Sun-ſhine, about that Pole, it is alwaies Day, till the Sun decreaſe in Declination: for the Sun goes not below their Horizon: as you may ſee by turning the Globe about upon its Axis: and in the oppoſite Pole, at the ſame diſtance, the Sun-ſhine not reaching thither, it will be alwaies Night, till the Sun decreaſe in Declination: becauſe the Sun Riſes not above their Horizon.

7. If you let the Globe hang ſteddy, you may ſee on the Eaſt ſide of the Globe, in what Places it grows Night; and on the

Weſt

Weſt ſide the Globe how by little and little the Sun encroaches upon it; and therefore there makes it Day.

8. If you make of Paper or Parchment a narrow Girdle, to begirt the Globe juſt in the Equinoctial, and divide it into 24. equal parts, to repreſent the 24. hours of Day and Night, and mark it in order with I, II, III, &c. to XII. and then begin again with I, II, III, &c. to the other XII. you may by placing one of the XII's upon the Equinoctial under the Meridian of your Place, have a continual Sun-Dyal of it, and the hour of the Day given on it, at once in two places; one by the parting the enlightned Hemiſphear from the ſhadowed on the Eaſtern ſide, the other by the parting the enlightned Hemiſphear from the ſhadowed on the Weſtern ſide the Globe. Much more might be ſaid on this Probleme: But the Ingenuous Artiſt may of himſelf find out diverſities of Speculations: therefore I forbear.

## Prob. XLVI.

### *To know by the Terreſtrial Globe in the Zenith of what Place of the Earth the Sun is.*

This may be performed by the former Probleme in the Day time, if the Sun ſhines: but not elſe. But to find it at all times, do thus. Bring the Place of your Habitation to the Meridian, and the Index of the Hour-Circle to 12; Then turn the Globe Eaſtwards, if Afternoon, or Weſtwards, if Before Noon, till the Index of the Hour-Circle paſs by ſo many Hours from 12. as your Time given is, either before or After-Noon: ſo ſhall the Sun be in the Zenith of that Place where the Meridian interſects the Parallel of the Suns Declination for that Day.

### Example.

*May* 10 at $\frac{3}{4}$. of an hour paſt 4. a clock After Noon, I would know in what Place of the Earth the Sun is in the *Zenith*. My Habitation is *London*. Therefore I bring *London* to the Meridian, and the Index of the Hour-Circle to 12. and becauſe it is After Noon: I turn the Globe Eaſtwards, till the Index paſſes through 4 hours and 3 quarters, or (which is all one) till 70 degrees 15 minutes of the Equator paſs through the Meridian.

ridian. Then I find by Prob. 5. the Suns Declination is 20. degrees 5. minutes which I find upon the Meridian, and in that Place juſt under that degree and minute on the Globe, the Sun is in the *Zenith*: which in this Example is in the North Eaſt *Cape* of *Hiſpaniola*.

Having thus found in what Place of the Earth the Sun is in the *Zenith*. Bring that Place to the Meridian, and Elevate its reſpective Pole according to its reſpective Elevation; ſo ſhall all Places cut by the Horizon have the Sun in their Horizon: Thoſe to the Eaſtwards ſhall have the Sun Setting; thoſe to the Weſtward ſhall have it Riſing in their Horizon: thoſe at the Interſection of the Meridian and Horizon under the Elevated Pole, have the Sun in their Horizon at loweſt, but Riſing; thoſe at the Interſection of the Meridian and Horizon under the Depreſſed Pole, have the Sun in their Horizon at higheſt, but Setting. Thus in thoſe Countries that are above the Horizon it is Day-light, and in thoſe but 18 degrees below the Horizon, it is Twilight: But in thoſe Countries further below the Horizon it is at that time dark Night: And thoſe Countries within the Parallel of the ſame number of degrees from the Elevated Pole that the Suns Declination is from the Equinoctial, have the Sun alwaies above the Horizon, till the Sun have leſs Reſpective Declination then the Elevated Pole; and thoſe within the ſame Parallel of the Depreſſed Pole have the Sun alwayes below their Horizon, till the Sun inclines more towards the Depreſſed Pole; As you may ſee by turning about the Globe; for in this poſition, that portion of the Globe intercepted between the Elevated Pole, and the Parallel Circle of 20. degrees 5. minutes from the Pole doth not deſcend below the Horizon: neither doth that portion of the Globe intercepted between the Depreſſed Pole and the Parallel Circle within 20. degrees 5. minutes of that Pole, aſcend above the Horizon.

## Prob. XLVII.

*To find in what different Places of the Earth the Sun hath the ſame* Altitude, *at the ſame time.*

Find by the former Probleme in what Place of the Earth the Sun is in the *Zenith*, and bring that Place on the Globe

Globe to the *Zenith*, and on the Meridian [there] ſcrew the Quadrant of Altitude, and turn it about the Horizon, deſcribing degrees of *Almicantars* thereby, as by Prob. 23. and all thoſe Countries in any *Almicantar* on the Globe ſhall have the Sun Elevated the ſame number of degrees above their Horizon. Thus thoſe Countries in the tenth *Almicantar* ſhall have the Sun Elevated 10. degrees above their Horizon; thoſe in the 20th *Almicantar* ſhall have the Sun Elevated 20 degrees above their Horizon; thoſe in the 30th, 30. degrees &c. So that you may ſee, when the Sun is in the *Zenith* of any Place, All the Countries or Cities in any *Almicantar* have the Sun in one heighth at the ſame time above their Horizon. But to find in what different Places the Sun hath the ſame heighth at the ſame time, as well Before or After Noon, as at Full Noon; and that in Countries that have greater Latitude then the Suns greateſt Declination, (and therefore cannot have the Sun in their *Zenith*,) requires another Operation.

Therefore, Elevate its reſpective Pole according to your reſpective Latitude; and let the Degree of the Brazen Meridian which is in the *Zenith* repreſent your Habitation, and the degree of the Ecliptick the Sun is in repreſent the Sun: Then bring the Sun to the Meridian, and the Index of the Hour-Circle to 12, and turn the Globe Eaſtwards, if Before Noon, or Weſtwards, if After Noon, till the Index point to the Hour of the Day. Then place the lower end of the Quadrant of Altitude to the Eaſt point of the Horizon, and move the upper end (by ſliding the Nut over the Meridian) till the edge of the Quadrant touch the place of the Sun: Then ſee at what degree of the Meridian the upper end of the Quadrant of Altitude touches the Meridian and ſubſtract that number of Degrees from the Latitude of your Place, and count the number of remaining degrees on the Meridian, on the contrary ſide the degree of the Meridian where the upper end of the Quadrant of Altitude touches the Meridian, and where that number of degrees ends on the Meridian, in that Latitude and your Habitations Longitude, hath the Sun the ſame heighth at the ſame time.

## Example.

*May* 10. at 53. minutes paſt 8. a clock in the Morning I

would know in what Place the Sun ſhall have the ſame Altitude it ſhall have at *London*. *London's* Latitude found by *Prob.* 1. is 51 ½ degrees Northwards: And becauſe the Elevation of the Pole is equal to the Latitude of the Place (as was ſhewed Prob. 15.) Therefore I Elevate the North Pole 51 ½ degrees, ſo ſhall 51 ½ degrees on the Meridian be in the *Zenith*: This 51 ½ degrees on the Meridian repreſents *London*. The Suns Place found by *Prob.* 3. is ♉ 29. Therefore I bring ♉ 29 to the Meridian, and the Hour Index to 12. on the Hour Circle. Then I turn the Globe Eaſtwards (becauſe it is before Noon) till the Index point at 8. hours 53 minutes on the Hour-Circle, and place the lower end of the Quadrant of Altitude to the Eaſt point in the Horizon, and ſlide the upper end either North or Southwards on the Meridian till the graduated edge cut the degree of the Ecliptick the Sun is in: Then I examine on the Meridian what degree the upper end of the Quadrant of Altitude touches; which in this example, I find is 38 ½ degrees. Therefore I ſubſtract 38 ½ from 51 ½ *Londons* Latitude, and there remains 13. Then counting on the Meridian 13. degrees backwards, from the Place where the Quadrant of Altitude touched the Meridian, I come to 25 ½ on the Meridian, Northwards. Therefore I ſay, In the North Latitude of 25 ½ degrees, and in the Longitude of *London* (which is in *Africa*, in the Kingdom of *Numidia*) the Sun *May* 10, at 53. minutes paſt 8. a clock in the Morning hath the ſame Altitude above the Horizon it hath here at *London*.

The Quadrant of Altitude thus applyed to the Eaſt point of the Horizon makes right angles with all points on the Meridian, even as all the Meridians proceeding from the Pole, do with the Equator: therefore the Quadrant being applyed both to the Eaſt point, and the Suns Place, projects a line to interſect the Meridian Perpendicularly in equal degrees; from which interſection the Sun hath at the ſame time equal Heighth, be the degrees few or many; for thoſe 5. degrees to the Northwards of this interſection, have the Sun in the ſame heighth that they 5 degrees to the Southwards have it: and thoſe 10, 20, 30. degrees, more, or leſs, to the Northwards, have the Sun in the ſame heighth that they have that are 10, 20. 30. degrees more or leſs to the Southwards: So that this *Prob.* may be performed another way more eaſily, with your Compaſſes, Thus: Having firſt rectified the Globe, and Hour Index, Turn about the Globe till the

the Hour Index point to the Hour of the Day; Then pitch one foot of your Compaſſes in the Suns Place, and extend the other to the degree of Latitude on the Meridian, which in this example is $51\frac{1}{2}$ degrees North; then keeping the firſt foot of your Compaſſes on the degree of the Sun, turn about the other foot to the Meridian, and it will fall upon $25\frac{1}{2}$ as before.

*Blaew* commenting upon this Probleme, takes notice how groſly they ere that think they can find the heighth of the Pole at any Hour of the Day, by the Suns height: becauſe they do not conſider that it is impoſſible to find the Hour of the Day, unleſs they firſt know the height of the Pole.

## PROB. XLVIII.

### *To find the length of the Longeſt and Shorteſt Artificial Day or Night.*

THE Artificial Day is that ſpace of Time which the Sun is above the Horizon of any Place: and the Artificial Night is that ſpace of Time which the Sun is under the Horizon of any Place. They are meaſured in the Hour Circle, by Hours and Minutes.

There is a conſtant unequallity of proportion in the Length of theſe Daies and Nights; which is cauſed both by the alteration of the Suns Declination, and the difference of the Poles Elevation.

Thoſe that inhabite on the North ſide the Equator have their longeſt Day when the Sun enters ♋; and thoſe that inhabite on the South ſide the Equator, have their longeſt Day when the Sun enters ♑. But to know how long the longeſt Day is in any North or South Elevation, Raiſe the North or South Pole according to the Elevation of the Place, and bring ♋ for North Elevation, or ♑ for South Elevation to the Meridian, and the Index of the Hour Circle to 12. Then turn the Globe about till ♋ for North Elevation, or ♑ for South Elevation, come to the Weſt ſide the Horizon, and the number of Hours and minutes pointed at on the Hour Circle, doubled, is the number of Hours and minutes of the Longeſt Day.

The length of the Night to that Day is found by ſubſtracting the length of the day from 24. for the remainder is the length of the Night.

The

The ſhorteſt Day in that Latitude is the length of the ſhorteſt Night, found as before. And the longeſt Night is of the ſame length with the longeſt Day.

## Example.

I would know the length of the longeſt Day at *London*. Therefore I Elevate the North Pole 51 ½ degrees, and bring ♋ to the Meridian, and the Index of the Hour Circle to 12. Then I turn ♋ to the Weſtern ſide the Horizon, and find the Index point at 8. hours 18. minutes, which being doubled makes 16. hours 36. minutes, for the length of the longeſt Day here at *London*.

## Prob. XLIX.

*To find how much the Pole is Raiſed, or Depreſſed, where the longeſt Day is an Hour longer or ſhorter then it is in your Habitation.*

Rectifie the Globe to the Latitude of your Place; and make a prick at that point of the *Tropick* which is at the Meridian; I mean at the *Tropick* of ♋, if your Habitation be on the North ſide the Equator; or ♑, if your Habitation be on the South ſide the Equator: And if you would know where the longeſt Day is juſt an hour longer then it is at your Habitation, turn the Globe to the Weſtward till 7 ½ degrees of the Equator paſs through the Meridian, and make there another prick on the *Tropick*: Then turn about the Globe till the firſt prick come to the Horizon; and move the Meridian through the notches of the Horizon till the ſecond prick on the *Tropick* come to the Horizon; ſo ſhall the arch of the Meridian contained between the Elevation of your Place, and the Degree of the Meridian at the Horizon, be the number of Degrees that the Pole is Elevated higher then it is in your Latitude.

## Example.

I would know in what Latitude the longeſt Day is an Hour longer then it is at *London*. Therefore I Rectifie the Globe to 51 ½ deg. and where the Meridian cuts the *Tropick* of ♋ I make a prick

a prick; then I note what degree of the Equator is at the Meridian, and from that degree on the Equator count $7\frac{1}{2}$ degrees to the Eaſtwards, and bring thoſe $7\frac{1}{2}$ degrees to the Meridian alſo; and again where the Meridian cuts the *Tropick* of ♋ I make another prick, ſo ſhall $7\frac{1}{2}$ degrees of the *Tropick* be contained between thoſe two pricks: Then I turn the Globe about, till the firſt prick comes to the Horizon, and (with a Quill thruſt between the Meridian and the Ball) I faſten the Globe in this poſition: Afterwards I move the Meridian through the notches of the Horizon, till the ſecond prick riſes up to the Horizon, and then I find $56\frac{1}{2}$ degrees of the Meridian cut by the Superficies of the Horizon: Therefore I ſay, In the Latitude of $56\frac{1}{2}$ degrees, the longeſt Day is an Hour longer then it is here at *London*.

But if you would know in what Latitude the Dayes are an Hour ſhorter, you muſt make your ſecond prick $7\frac{1}{2}$ degrees to the Weſtwards of the firſt, and after you have brought the firſt prick to the Horizon, you muſt depreſs the Pole till the ſecond prick deſcends to the Horizon: ſo ſhall the degree of the Meridian at the Horizon, ſhew in what Elevation of the Pole the Daies ſhall be an Hour ſhorter.

By this Probleme may be found the Alteration of Climates: for (as was ſaid in the Definition of *Climates*, *Book* 1. *fol.* 28.) Climates alter according to the half-hourly increaſing of the Longeſt Day: therefore the Latitude of $56\frac{1}{2}$ degrees having its Daies increaſed an whole Hour) is diſtant from the Latitude of *London* by the ſpace of two Climates.

## Prob. L.

*The Suns Place given, to find what alteration of* Declination *he muſt have to make the Day an Hour longer, or ſhorter: And in what number of Dayes it will be.*

Rectifie the Globe to the Latitude of the Place, and bring the Suns place to the Eaſt ſide the Horizon, and note againſt what degree of the Horizon it is: then bring one of the Colures to interſect the Horizon in that degree of the Horizon, and at the point of Interſection make a prick in the Colure; and obſerve what degree of the Equator is then at the Meridian: Then turn the Globe Weſtward, if the Daies ſhorten; but Eaſtwards, if

they lengthen, till 7 ½ degrees of the Equator pass through the Meridian, and where the Horizon intersects the same Colure, make another prick in the Colure: Afterwards bring the Colure to the Meridian, and count the number of degrees between the two pricks, for so many degrees must the Suns Declination alter to lengthen or shorten the Day an Hour.

## Example.

The Suns Place is ♈ 10. I would know how much he must alter his Declination before the Day is an Hour longer here at *London*. Therefore I rectifie the Globe to the Latitude of *London*, and bring ♉ 10. to the East side the Horizon, and find it against 24 ½ degrees from the East point: therefore I bring one of the Colures to this 24 ½ degrees, and close by the edge of the Horizon I make a prick with black lead, in the Colure: then keeping the Globe in this position, I look what degree of the Equator is then at the Meridian, and find 25 ¼, and because the Daies lengthen, I turn the Globe Eastwards, till 7 ½ degrees from the foresaid 25 ¼ pass through the Meridian: then keeping the Globe in this position, I make another prick in the Colure, and bringing this Colure to the Meridian, I find a little more then 5 degrees of the Meridian contained between the two pricks: therefore I say, when the Sun is in ♉ 10. degrees, he must alter his Declination a little more then 5 degrees, to make the Day an Hour longer.

Now to know in what number of Daies he shall alter this Declination, you must find the Declination of the two pricks on the Colure, as you found the Suns Declination by Prob. 5. and the Arch of the Ecliptick that passes through the Meridian while the Globe is turned from the first pricks Declination to the second pricks Declination, is the number of Ecliptical degrees that the Sun is to pass while he alters this Declination: and the degree of the Ecliptick then at the Meridian is (with respect had to the Quarter of the Year) the place the Sun shall have when its Declination shall be altered so much as to make the Day an Hour longer.

Thus having the Suns first place given, and its second place found; you may by finding those two places on the Plain of the Horizon, also find the number of Daies comprehended between them, as you are taught by the fourth Probleme.

This

This Probleme thus wrought for different Times of the Year, will ſhew the falacy of that Vulgar Rule which makes the Day to be lengthned or ſhortned an Hour in every FifteenDaies: when as the lengthning or ſhortning of Daies keeps no ſuch equality of proportion: for when the Sun is neer the Equinoctial points the Daies lengthen or ſhorten very faſt: but when he is neer the Tropical points, very ſlowly.

## PROB. LI.

*Of the Difference of* Civil *and* Natural Daies, *commonly called the* Equation *of* Civil Daies. *And how it may be found by the* Globe.

THe Civil Day is that ſpace of Time containing juſt 24. Hours, reckoned from 12 a clock on one Day to 12 a clock the next Day; in which ſpace of Time the Equinoctial makes upon the Poles of the World a Diurnal Revolution. The Natural Day is that ſpace of Time wherein the Sun moveth from the Meridian of any Place to the ſame Meridian again. Theſe Daies are at one time of the Year longer then at another; and at all Times longer then the Civil Daies. There is but ſmal diſcrepancy between them, yet ſome there is, made by a two-fold Cauſe. For firſt, The Suns Apparent motion is different from his true motion; He being much ſlower in his *Apogeum* then he is in his *Perigeum*: For when the Sun is in his *Apogeum* he ſcarce moves 58 minutes from Weſt to Eaſt in a Civil Day, but when he is in his *Perigeum* he moves above 61 minutes in a Civil Day: and therefore increaſes his Right Aſcenſion more in equal Time.

The ſecond Cauſe is the difference of Right Aſcenſions anſwerable to equal parts of the Ecliptick: for about ♋ and ♑ the differences of Right Aſcenſions are far greater then about ♈ and ♎: for about ♈ and ♎ the Right Aſcenſion of 10. degrees is but 9. degrees 11. minutes; but about ♋ and ♑ the Right Aſcenſion of 10 degrees will be found to be 10. degrees 53. minutes, as by the Globe will appear.

But becauſe of the ſmalneſs of the Globes graduation, you cannot actually diſtinguiſh to parts neer enough for the ſolution of this Probleme, if you ſhould enquire the difference in length of two ſingle Daies; it will be requiſite to take ſome number of

Daies together; Suppose 20. Therefore find by Prob. 3. the Places of the Sun for the beginning and ending of those Daies you would compare; and find the Right Ascensions answerable to each place in the Ecliptick; and also the differences of Right Ascensions answerable to the Suns motion in each number of Daies: Then compare the differences of Right Ascensions together; and by substracting the lesser from the greater, you will have the number of degrees and minutes of the Equator that have passed through the Meridian more in one number of Daies then in the other number of Daies: which degrees of the Equator converted into Time, is the number of minutes that the one number of Daies is longer then the other number of Daies.

## Example.

I would know what difference of Time there is in the length of the first 20. Daies of *December*, and the first 20. Daies of *March*. I find by Prob. 3. the Suns place *December* 1, is ♐ 19. 45. at the end of 20 Daies, *viz.* on the 21 Day his place is ♑ 10. 11. The Suns place *March* 1. is ♓ 21. 16. at the 20. Daies end, *viz. March* 21. his place is ♈ 11. 3.

I find by Prob. 26. the Right Ascension answerable to

| | | |
|---|---|---|
| ♐ 19. 45 | is | 258. 10. |
| ♑ 10. 11 | | 280. 25. |
| ♓ 21. 16 | | 352. 00. |
| ♈ 11. 3 | | 9. 40. |

and the difference of Right Ascensions contained between the first Day in each Moneth, and the 21 of the same Moneth, by substracting the lesser from the greater is for

| | | |
|---|---|---|
| 258. 10. | And for | 352. 00. |
| 280. 25. | | 9. 40. |
| 22. 15 | | 17. 40. |

But note, because the Vernal Colure, where the degrees of Right Ascension begin and end their account, is intercepted in the Arch of the Suns motion from the first to the 21. of *March*, therefore instead of substracting the lesser number of degrees of Right Ascension from the greater, *viz.* 9. 40 from 352. I do for finding the difference of the Right Ascensional arch of the Suns motion in those 20 Daies, sustract the foresaid 352 degrees from 360, and the remains is 8. which is the difference of Right Ascension from ♓ 21, 16. to the Equinoctial Colure: to which 8 adding

adding 9 degrees 40 minutes, the Right Aſcenſion from the Equinoctial Colure, to ♈ 11. 3. it makes 17 degrees 40. minutes for the difference of Right Aſcenſions between ♓ 21. 16. and ♈ 11. 3 Then I find the difference of this Difference of Right Aſcenſion, by ſubſtracting the leſs from the greater, *viz.* 17. 40. from 22. 15. and the remains is 4. degrees 35. minutes, for the number of degrees and minutes of the Equator that paſs through the Meridian in the firſt 20 Daies in the Moneth of *December* more then in the firſt 20 Daies of the Moneth of *March*: which 4. degrees 35. minutes converted into Time, gives 19. minutes, that is, a quarter of an Hour and 4 minutes that the firſt 20 Daies of *December* aforeſaid, are longer then the firſt 20 Daies of *March*.

## Prob. LII.

### *How to find the Hour of the Night, when the* Moon *ſhines on a* Sun Dyal, *by help of the* Globe.

Rectifie the Globe, and find by Prob. 54. or an *Ephemeris*, the Moons place at Noon: Bring it to the Meridian, and the Index of the Hour Circle to 12. and turn about the Globe till the Index of the Hour Circle points to the ſame Hour the ſhade of the Moon falls on, on the Sun Dyal. Then by Prob. 3. find the Suns place at Noon, and ſee how many degrees of Right Aſcenſion are contained between the Suns place and the degree of the Equator at the Meridian, when the Index of the Hour Circle is brought to the Hour the Moon ſhines on in the Sun Dyal; for thoſe number of degrees converted into Time, ſhall be the Time from Noon, or the Hour of the Night. Only note, Reſpect muſt be had to the motion of the Moon from Weſt to Eaſt, for ſo ſwift is her mean motion, that it is accounted to be above 12. degrees in 24 Hours; that is 6 degrees in 12 Hours, 3 degrees in 6 Hours, &c. and this alſo converted into Time, as aforeſaid, you muſt add proportionably to the Time found from Noon; and the ſum ſhall give you the true Hour of the Night.

### Example.

Here at *London*, I deſired to know the Hour of the Night *January* 6. this preſent Year 1658. The Moons place found by

an *Ephemeris*, or for want of an *Ephemeris*, by Prob. 54. is in ♓ 21. degree 22. minutes; Therefore I rectified the Globe to *Londons* Latitude, and brought ♓ 21. 22. minutes to the Meridian, and the Index of the Hour Circle to 12. then by Prob. 3. I found the Suns place in ♍ 26. degrees 46. minutes, and by Prob. 26. I found his Right Ascension to be 300 degrees; Then I turn'd about the Globe, till the Index of the Hour Circle pointed at 10 Hours, and at the degree of the Equator at the Meridian I made a prick; then I counted the number of degrees of the Equator contained between the foresaid 300 deg. and this prick, and found them 111¼ degrees, which converted into Time, by allowing 15 degrees for an Hour, gives 7 hours, 25 minutes, Time from Noon: which if the Moons motion were not to be considered, should be the immediate Hour of the Night: But by the Rule aforesaid, the Moons motion from West to East, in 7 hours 25 minutes is 3 degrees 42 minutes, and this 3 degrees 42 minutes being converted into Time, is 14 minutes more, which being added to 7 hours 25 minutes: make 7 hours 39 minutes, for the true Hour of the Night.

## Prob. LIII.

### *To find the* Dominical Letter, *the* Prime, Epact, Easter Day, *and the rest of the* Moveable Feasts, *for ever.*

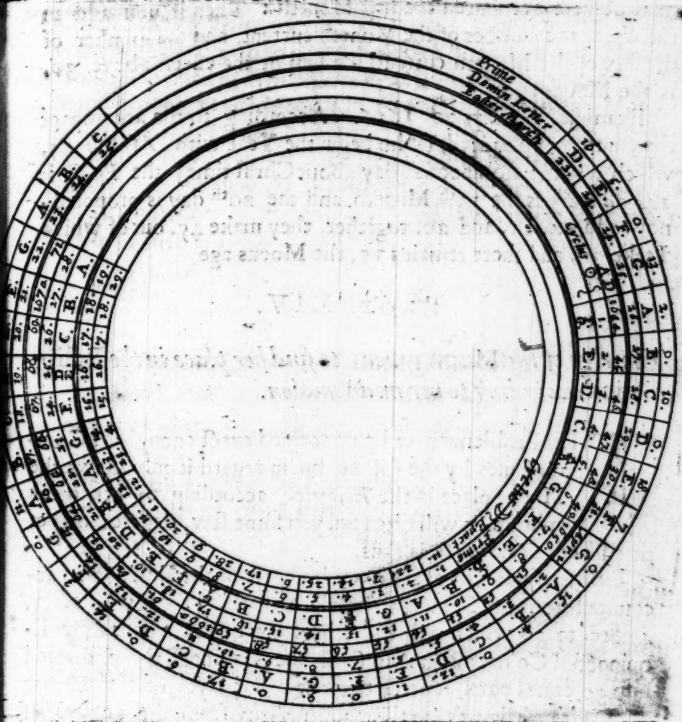
THough these Problemes cannot be performed by the Globe, because of the several changes, and irregular accounts that their Rules are framed upon, yet because they are of frequent and Vulgar use, and for that the solution of many other Questions will have dependency on the knowledge these; Therefore I have thought fit here to inserte this Table of Mr *Palmers*, by which you may find them All.

I shall not insist upon the Reasons of the several changes of Letters, and Numbers, Himself having already very learnedly handled that subject, in his Book of the *Catholick Planisphear*, *Book* 1. *Chapter* 11. (to which I refer you) Neither shall I need to give you any other Instructions for finding what is here proposed, then what himself hath given in his fourth *Book*, *Chapter* 66, and part of 67. Therefore take it as he there delivers it.

An Exam-

An Example, shall serve here instead of a Rule. For the Year 1657. I would know all these: wherefore I seek the Year 1657. in the Table of the Suns *Cycle*, and over against it, I find 14. for the Year of the *Cycle* of the Sun, and D for the *Dominical Letter*. And note here, that every *Leap-year* hath 2 *Dominical Letters* (as 1660. hath A G) and the first (*viz.* A) serveth that Year till *February* 25, and the second (G) for the rest of the Year. And note that these Letters go alwayes backwards when you count forwards (as B A, then G F, &c. not F G, and then A B) as you may see by the Table.

Then in the Table of the *Cycle* of the Moon, I have for the Year 1657. the *Prime* 5. the *Epact* 25. Those had, I go to the Table for *Easter*, and seek there in the first rank the *Prime* 5, and



under

under it in the middle rank ſtands E; that is not my *Dominical Letter*; therefore I ſeek not backward, but alwayes forward in the middle rank, till I come to my *Dominical Letter* D. and under it I find in the third rank *March* 29. upon which *Eaſter* day falls this Year 1657. The reſt of the moveable *Feaſts* may be had by their diſtances from *Eaſter*, which are alwayes the ſame. Onely for *Advent Sunday*, remember that the next Sunday after *November* 26 is *Advent Sunday*. Read Book 1. 11. and that will ſufficiently inſtruct you with this Example.

## *To find the Age of the* Moon.

Remember firſt that the *Epact* begins with *March*, which muſt be here accounted the firſt Moneth: Then if you add to the *Epact* the number of the Moneth current, and the number of the day of the Moneth current, the ſum or the exceſs above 30, is the Moons age.

Example. *January* 20. 1656. According to the accompt of the Church of *England*, (who begin the Year with *March* 25. which was the Equinoctial day about Chriſt time) the *Epact* is 14. *January* is the 11th Moneth, and the 20th day is propoſed; now add 14. 11. and 20. together, they make 45. out of which I take 30. and there remains 15, the Moons age.

## Prob. LIV.

## *The Age of the* Moon *given, to find her place in the* Ecliptick *according to her mean motion.*

THis Probleme may be performed exact enough for Common uſes by the Globe, but in regard it only ſhews the Moons place in the *Ecliptick*, according to her mean motion, it will often fail you ſome few degrees of her true Place. The work is thus,

Firſt ſet figures to every twelfth degree of the Equinoctial, accounted from the Equinoctial Colure, marking them with 1, 2, 3, 4. &c. to 30 which will end where you began *viz.* at the Equinoctial Colure again: ſo ſhall the Equinoctial be divided into 30 equal parts, repreſenting the 30 Dayes of the Moons Age. Theſe figures (to diſtinguiſh them from the degrees of the Equator) were beſt be writ with Red Ink. When

When you would enquire the Moons Place, Elevate the North Pole 90 degrees, that is, in the *Zenith*, ſo ſhall the Equator ly in the Horizon: Then bring the Equinoctial Colure againſt the Day of the Moneth in the Horizon, ſo ſhall the Moons Age written in Red figures, ſtand againſt the Signe and degree in the Horizon that the Moon is in at that Time.

## Example.

*September* 28. 1658. I would know the Moons place in the *Ecliptick*, ſhe being then 12 Daies old. Therefore I Elevate the North Pole 90 degrees above the Horizon, and turn the Globe about till the Equinoctial Colure come to *September* 28. in the Circle of Daies on the Horizon; then looking againſt what Signe and degree of the *Ecliptick* Circle in the Horizon the 12th diviſion in Red figures ſtands, I find ♐ 9. which is the Signe and degree the Moon is in, according to her mean Motion.

This Probleme may be applyed to many Uſes: for, having the Moons Place you may find the Time of her Riſing, Southing, Setting, and Shining &c. by working with her, as you were taught to work with the Sun, in ſeveral fore-going Problemes, proper to each purpoſe.

## Prob. LV.

### *Having the* Longitude *and* Latitude, *or* Right Aſcenſion *and* Declination *of any* Planet, *or* Comet, *to place it on the* Globe, *to correſpond with its place in* Heaven.

Planets and Comets cannot be placed on the Globe ſo as their places will long retain correſpondence with their places in Heaven; Becauſe as was ſaid *Chap.* 44. they have a continual motion from Weſt to Eaſt upon the Poles of the *Ecliptick*: yet never-the-leſs you may by having their Longitude and Latitude, or Right Aſcenſion and Declination, for any ſet Time, place a Mark for them on the Globe, either with Ink if your Globe be Varniſht, for then you may with a wet finger wipe it off again; or with Black-lead, if it be not Varniſht, and then you may rub it out again with a little White

Bread: which Mark for that Time, will as effectually ſerve you to work by, as any of the Fixed Stars placed on the Globe will do.

Therefore if the Longitude and Latitude of any Planet, or Comet, be given; Do thus, Elevate the North Pole, if the Latitude given be North; but if the Latitude given be South, Elevate the South Pole $66\frac{1}{2}$ degrees; and place the Pole of the *Ecliptick* in the *Zenith*, and over it ſcrew the Quadrant of Altitude: ſo ſhall the *Ecliptick* lie in the Horizon; and the Quadrant of Altitude being turned about the Horizon ſhall paſs through all the Degrees of Longitude: Then find the point of given Longitude in the *Ecliptick*, and bring it to the Quadrant of Altitude, and hold it there: Then count upwards on the Quadrant of Altitude the number of degrees and minutes of given Latitude, and at the point where the number ends, cloſe to the Quadrant of Altitude, make a ſmal Prick, and that Prick ſhall repreſent the Planet or Comet you were to place on the Globe.

If it be the Right Aſcenſion and Declination of a Planet or Comet that is given; you muſt find the degree and minute of Right Aſcenſion on the Equinoctial, and bring it to the Meridian, and keep the Globe there ſteddy; then find the degree and minute of Declination on the Meridian, and under that degree and minute on the Globe make a Prick, and that Prick ſhall repreſent the Planet, or Comet, as aforeſaid.

If it be ♄, or ♃ that this Prick is to repreſent, it may ſtand on the Globe ſometimes a Week or a Fortnight, without much difference from the Planets place in Heaven. But if the Prick were to repreſent the other Planets, you muſt (in regard of their ſwift motion) alter it very often, eſpecially for the Moon; for ſo ſwift is her motion, that in every two Hours ſhe alters about a degree in Longitude.

Having thus placed this Mark on the Globe, you may find out the Time of its ſeveral Poſitions, and Aſpects, if you work by it as you are directed to work by the Sun, in the ſeveral reſpective Problemes throughout this Book.

*The End of the Second Book.*

# The Third BOOK,

*Being the Practical Use of the*

# GLOBES.

*Applyed to the Solution of* Problemes

In the Art of

# NAVIGATION.

## *PRÆFACE.*

BEcause *the Art of Navigation consists aswell in the knowledge of* Astronomical *and* Geographical Problemes, *as in Problemes meerly Nautical; Therefore I must desire the Artist to seek in the last Book such Problemes as are only* Astronomical *or* Geographical. *For my Designe is here to collect such Problemes as are only used in the Art of* Navigation, *some few particulars excepted, as for finding* Latitude, Longitude, Course, Distance, *&c. Which though they are handled in that Book, yet for their exceeding Vtility in the* Art *of* Navigation, *and for that what there is given, cannot alwayes be had to work by; therefore in this Book I have mentioned divers other Observations, which being made or had, you may by the Rules proper for each Observation find what shall be proposed.*

## Prob. I.

*The* Suns Amplitude *and* Difference *of* Aſcenſion *given, to find the* Heigth *of the* Pole, *and* Declination *of the* Sun.

ELevate the Pole ſo many degrees as the Difference of the Suns Aſcenſion is, and ſcrew the Quadrant of Altitude to the *Zenith*, and bring the firſt point of ♈ to the Meridian, then number on the Quadrant of Altitude upwards the complement to 90. of the Suns Amplitude, and move the Quadrant of Altitude till that number of degrees cuts the Equator; So ſhall the Quadrant cut in the Horizon the degree of the Pole Elevation; and in the Equator the degree of the Suns Declination.

### Example.

The difference of Aſcenſion is 27. degrees 7. minutes. Therefore I Elevate the Pole 27. degrees 7. minutes above the Horizon, and ſcrew the Quadrant of Altitude to 27. degrees 7. minutes, which is in the *Zenith*: then I bring the firſt point of ♈ to the Meridian, and number on the Quadrant of Altitude upwards 56. degrees 40. minutes, the Complement of the Suns Amplitude, and bring that degree to the Equator; then I ſee in what degree of the Horizon the Quadrant cuts the Horizon, and find 51 $\frac{1}{2}$, which is the Elevation of the Pole: then looking in what degree of the Equator the Quadrant of Altitude cuts the Equator, I find 20 degrees, 5 min. which is the Declination of the Sun at the ſame Time.

## Prob. II.

*The* Suns Declination *and* Amplitude *given, to find the* Poles Elevation.

ELevate the Pole ſo many degrees as the Complement of the Suns Amplitude is; and ſcrew the Quadrant of Altitude in

in the *Zenith*, and bring the first point of ♈ to the Meridian: Then count on the Quadrant of Altitude to the Degree of the Suns Declination, and bring that degree to the Equinoctial; and the degree of the Equinoctial cut by that degree of the Quadrant of Altitude, is the degree of the Poles Elevation.

## Example.

The Suns Amplitude is 33. degrees 20. minutes, his Declination is 20 degrees 5 minutes, his Complement of Amplitude to 90. is 56 degrees 7 minutes. Therefore I Elevate the Pole 56. degrees 7 minutes above the Horizon, and screw the Quadrant of Altitude to 56 degrees 7 minutes which is in the *Zenith*: Then I bring the first point of ♈ to the Meridian, and number on the Quadrant of Altitude upwards 20. deg. 5 min. for the Suns Declination, this 20th degree 5 minutes, I bring to the Equinoctial, and find it cut there 51 $\frac{1}{2}$. degrees, for the Heigth of the Pole.

## Prob. III.

### *The* Suns Declination *and* Hour *at* East *given, to find the* Heigth *of the* Pole.

ELevate the Pole so many degrees as the Suns Declination is, and screw the Quadrant of Altitude in the *Zenith*: Then convert the Hours or minutes past 6. given into degrees; by allowing 15 degrees for every Hour of Time, and for every minute of Time 15 minutes of a Degree; and number those degrees or minutes in the Horizon from the East Southwards; so shall the Degree of the Quadrant of Altitude cut by the Equator be the Complement of the heigth of the Pole.

## Example.

The Suns Declination is 20 deg. 5 min. Therefore I Elevate the Pole 20 degrees 5 minutes, and also screw the Quadrant of Altitude to 20 degrees 5 minutes which is in the *Zenith*: the Hour the Sun comes to be at East is 8 a clock 53 minutes, that is, 1 Hour 7 minutes after 6. Therefore I convert 1 Hour 7 mi-

nutes into Degrees, as before, and it gives 16 degrees 50 minutes; which number of degrees and minutes I count from the East point Southwards, and thither I bring the Quadrant of Altitude: Then I look in what degree of the Quadrant of Altitude, the Equator cuts, and find 38 ½, which is the Complement of the Poles Heigth, *viz.* 51 ½ degrees for the Heigth of the Pole.

In this Probleme the Declination of the Sun and Elevation of the Pole bears the same Denomination of either North or South, for when the Declination and the Elevation are different the Sun cannot come to the East point.

## Prob. IIII.

*The* Declination *of the* Sun *and his* Altitude *at* East *given, to find the* Heigth *of the* Pole.

Elevate the Pole to the Complement of the Suns Altitude, and screw the Quadrant of Altitude to the *Zenith*: Then bring the Equinoctial point ♈ to the Meridian, and number on the Quadrant of Altitude the degrees of the Suns Declination, and bring that degree to the Equinoctial, and note the degree it cuts; for its Complement to 90 is the Heigth of the Pole.

### Example.

*May* 10. The Suns Declination is 20 degrees 5 minutes; His Altitude at East is 25 degrees 55 minutes here at *London*: I enquire the Heigth of the Pole. Therefore I substract 20. 5 min. from 90 the remains is 69 deg. 55 min. for its Complement; wherefore I bring 69 deg. 55 min. of the Meridian to the Horizon; and to 69 deg. 55 min. which is in the *Zenith*, I screw the Quadrant of Altitude then I bring ♈ to the Meridian, and count on the Quadrant of Altitude upwards 20 deg. 5 min. and move it about the Equinoctial till those 20 deg. 5 min. touch the Equinoctial, which I find to be in 38 ½ degrees, Therefore I substract those 38 ½ from 90, and the remains is 51 ½ degrees, Therefore I say the Pole here at *London* is Elevated 51 ½ degrees.

The Declination and the Elevation is alwaies the same, either North or South, for when they alter their Denominations the Sun at East can have no Altitude, neither can it indeed reach the East

East point: and therefore in this example, becauſe the Declination of the Sun is North, it is the North Pole that is Elevated here at *London*.

### *To perform the ſame otherwiſe, with a pair of* Compaſſes.

Take off with your Compaſſes from the Equator or Quadrant of Altitude the number of degrees of Altitude obſerved, and place one foot at the beginning of ♈ on the inner edge of the Horizon, and extend the other directly upwards towards the *Zenith*: Then move the Brazen Meridian through the notches of the Horizon till the other point of your Compaſſes (reſpecting the *Zenith*) reach the Parallel of the Suns Declination: So ſhall the number of degrees on the Meridian be the number of degrees that the Pole is Elevated above the Horizon; and is either North or South according as the Suns Declination is: as before.

This may yet otherwiſe be performed with the Quadrant of Altitude, by taking the Nut off the Meridian, and laying the edge of its Index (ſpecified in *Chap.* 1. *Sect.* 6. of the firſt *Book*) exactly on the East line of the Horizon: for when that lies ſtraight between the point of East on the outer Verge of the Horizon, and the beginning of ♈ in the inner Verge of the Horizon, then ſhall the upper end of the Quadrant of Altitude point directly to the *Zenith*: and if then you turn the Meridian through the notches of the Horizon till the Suns Altitude on the Quadrant of Altitude cut the Parallel of Declination, you will have on the Meridian the heigth of the Pole: as before.

## Prob. V.

### *By the* Suns Declination *and* Azimuth *at* 6. *of the Clock given, to find the Heigth of the* Pole, *and* Almicantar *at* 6.

Elevate the Pole ſo many degrees as the Suns *Azimuth* is at 6. and ſcrew the Quadrant of Altitude in the *Zenith*, and bring the firſt point of ♈ to the Meridian: Then number on the Quadrant of Altitude upwards the Complement of the Suns Declination, and bring that degree to the Equator: So ſhall the degree

degree of the Horizon cut by the Quadrant of Altitude be the Complement of the Poles Elevation; and the degree of the Equator cut by the Quadrant of Altitude shall be the *Almicantar* of the Sun at 6. of the clock.

## Example.

The Suns *Azimuth* at 6 is 12 $\frac{3}{4}$ degrees: Therefore I Elevate the Pole 12 $\frac{3}{4}$, and screw the Quadrant of Altitude to 12 $\frac{3}{4}$ degrees which is in the *Zenith*: Then I bring the first point of ♈ to the Meridian; The Suns Declination is 20 degrees 5 minutes. Therefore I number on the Quadrant of Altitude 69 deg. 55 min. which is the Complement of 20 deg. 5 min. to 90. this 69 deg. 55 min. on the Quadrant of Altitude I bring to cut the Equator, and find when 69 deg. 55 min. cuts the Equator, that the Quadrant of Altitude cuts the Horizon, in 38 $\frac{1}{2}$ deg. which is the Complement of the Poles Elevation: and at the same time the Quadrant of Altitude also cuts the Equator in 15 $\frac{1}{2}$ degrees; which is the *Almicantar* or Altitude of the Sun at 6. a clock.

## Prob. VI.

*By the* Hour *of the* Night *and a known* Star *Observed* Rising *or* Setting, *to find the* Heigth *of the* Pole.

REctifie the Hour Index, by Prob. 2. of the former Book; and turn the Globe Westwards till the Hour Index points at the Hour of the Night; fasten the Globe there, and turn the Meridian through the notches of the Horizon till the known Star come to the East side the Horizon, if the Star be Rising, or the West if it be Setting; so shall the degrees of the Poles Elevation be cut by the Horizon under the Elevated Pole; and it North or South according as the Elevated Pole of the Globe is.

## Prob. VII.

*Two* Places *given in the same* Latitude, *to find the* Difference *of* Longitude.

BRing the first Place to the Meridian, and note the number of degrees of the Equinoctial that comes to the Meridian with

with it; then Bring the other place to the Meridian and note the number of degrees of the Equator that comes to the Meridian with it: and by ſubſtracting the leſſer number from the greater you have the difference of Longitude. This needs no Example.

## PROB. VIII.

*Two Places given in the ſame* Longitude, *to find the Difference of* Latitude.

BRing the Places to the Meridian, and the degrees of the Meridian over the two Places is the Latitudes of them both, and by ſubſtracting the leſſer number of degrees from the greater you will have the difference of Latitude.

## PROB. IX.

Courſe *and* Diſtance *between two Places given, to find their Difference in* Longitude *and* Latitude.

SEek the Rhumb you have ſailed upon, as in Prob. 34. of the laſt Book, and upon that Rhumb make a mark for the Place you departed from; then with your Compaſſes take off from the Equinoctial the number of Leagues you have ſailed upon that Rhumb, by allowing a degree for every 20. Leagues, and place one foot of your Compaſſes upon that mark, and where the other foot falls on that Rhumb make a ſecond mark; then by bringing the firſt mark to the Meridian, you will ſee on the Meridian the Latitude of that mark, and in the Equator the Longitude as in Prob. 2. of the laſt Book: and by bringing the ſecond mark alſo to the Meridian, you will as before, find the Longitude and Latitude of the ſecond mark alſo. Then by ſubſtracting the leſſer Latitude from the greater Latitude, and the leſſer Longitude from the greater Longitude, you will have the difference remaining, both of Longitude and Latitude you are arived into.

## Prob. X.

*To find how many Miles are contained in a Degreee of any* Parallel.

Every Degree of the Equinoctial contains 20. Englifh Leagues and every League 3. Englifh Miles: But in every Parallel to the Equinoctial, the Degrees diminifh more and more even to the Pole, where they end in a point. Therefore a Degree in any Parallel cannot contain fo many Miles as a Degree in the Equinoctial. Now that you may know how many Miles are contained in a Degree of any Parallel to the Equinoctial. Do thus, Meafure with your Compaffes the width of any number of Degrees in any given Parallel; fuppofe (for Examples fake) 10. Degrees in the Parallel of 51 $\frac{1}{2}$; Examine in the Equator, how many Degrees of the Equator they will make, and you will find 6 $\frac{1}{5}$. Therefore 1. Degree in the Equator making 60 Miles, 6. Degrees makes 360. to which add for the $\frac{1}{5}$ part 12 Miles, makes 372 Miles, to be the Meafure of 10 Degrees in the Parallel of 51 $\frac{1}{2}$. So that by dividing 372. by 10. you have 37 Miles for the length of a Degree, from Eaft to Weft in the Parallel of 51 $\frac{1}{2}$ Degrees.

## Prob. XI.

*The* Rhumb *you have failed upon, and the* Latitudes *you departed from, and are arived to, given, to find the* Difference *of* Longitude, *and the number of Leagues you have Sailed.*

First feek the Rhumb you have failed on, and pafs it through the Meridian till it cuts in the Meridian the Latitude you departed from; and keeping the Globe there fteddy make a mark clofe by the Meridian, under that Latitude and in that Rhumb on the Globe, and note in the Equinoctial the degree of Longitude at the Meridian: then pafs that Rhumb through the Meridian again, till it cuts in the Meridian the Latitude you are arived to; and in that Rhumb and Latitude make on the Globe another mark, and examine in the Equinoctial the

the Longitude of the ſecond mark; for the difference between the firſt and ſecond mark, is the difference of Longitude. Then open your Compaſſes to one Degree of the Equinoctial, and by meaſuring along in the Rhumb, count how many times that Diſtance is contained between the two points in that Rhumb: for ſo many times 20. Leagues is the Diſtance you have ſailed.

## Example.

I ſail upon the North Weſt Rhumb from the Latitude of 10. degrees, into the Latitude of 30. degrees 40. minutes. Therefore I find the North Weſt Rhumb, and turn the Globe through the Meridian till this Rhumb cut the Meridian in the firſt Latitude, *viz.* in 10. degrees, and directly under 10. degrees upon the Rhumb I make a prick, and alſo find 10 degrees 3 minutes, of the Equator at the Meridian, for the Longitude of the Firſt Place. Then I turn the Globe again through the Meridian, till the ſame Rhumb cut the Meridian in the ſecond Latitude, *viz.* in 30 degrees 40 minutes, and directly under thoſe 30 degrees 40 minutes upon the ſame Rhumb, I make another prick, which repreſents the Place I am arrived to: I examine the Longitude of this prick, as before, and find it 32 degrees 10 minutes. Therefore I ſubſtract the firſt Longitude, *viz.* 10 degrees 3 minutes from the ſecond Longitude, *viz.* 32 degrees 10 minutes, and there remains 22 degrees 7 minutes, for the Difference of Longitude.

Then for examining the Diſtance, I open my Compaſſes to 1. degree on the Equinoctial and meaſure upon the Rhumb how oft that Diſtance is contained between the two pricks, and find $29\frac{1}{4}$, that is, 29 degrees 15 minutes, which multiplyed by 20. gives 585. for the number of Leagues ſailed upon that Rhumb.

The reaſon why I open the Compaſſes no wider then to 1 degree, is becauſe the Rhumbs being Circular or crooked lines the diſtance on them may be meaſured more exactly by often counting that 1 degree in them, then if the Compaſſes had bin opened to many degrees. Thus if the Compaſſes had been opened wide enough to reach between the two pricks aforeſaid, I ſhould not have had above 583. Leagues for the diſtance between the two Places: neither is there indeed more great Circle diſtance between them; But I ſailed upon a Rhumb, that is, I follow'd

the Courſe of a Circular winding line, and ſo fetcht a Compaſs about to come to theſe two pricks; and therefore I have in truth ſailed 585. Leagues. For the ſegment of a Rhumb between two Places is alwaies greater then a ſtraight line drawn betwixt them; yea ſometimes by half or more in Places neer either Pole.

Note, If you be not very curious in opening your Compaſſes to this ſmal diſtance, you may in oft turning them about upon the Rhumb commit error in your meaſuring: therefore when you have taken the Diſtance of one degree, try if you neither gain or looſe any thing in meaſuring 10, or 20. degrees of the Equinoctial by them: for then your Compaſſes are opened to a width exact enough for your purpoſe.

## Prob. XII.

*The* Longitudes *and* Latitudes *of two Places given, to find* Courſe, *and* Great Circle *diſtance between them.*

FInd on the Globe the Longitudes and Latitudes given, and make pricks to either Longitude and Latitude: If any Rhumb paſs from one place to the other, that is (without more adoe) the Rhumb ſought. But if no Rhumb paſs through; Take the Rhumb that runs moſt Parallel to the two pricks: for that ſhall be the Rhumb or the neereſt Rhumb that theſe two pricks Bear on. An Example of this, ſee in Prob. 34. of the Laſt Book: And the Great Circle Diſtance between theſe two pricks, you may find as by Prob, 33. of the ſame Book.

## Prob. XIII.

*The* Latitude *you departed from, and the* Latitude *you are arrived to, and the number of Leagues you have ſailed given, to find the* Rhumb *you have ſailed on, and difference of* Longitude.

MAke a prick on the Globe in the Latitude you departed from: then open your Compaſſes to the number of Leagues you have ſailed, by taking for every 20. Leagues 1. degree of the Equator, half a degree for

10.

10 Leagues, a quarter of a Degree for 5 Leagues, and ſo proportionably for any other number of Leagues. Place one foot of your Compaſſes in the prick made for the Latiude you departed from, and extend the other towards the Latitude you are arived to, and diſcribe an occult Arch; Turn the Globe till this occult Arch come to the Latitude on the Meridian, and where the Latitude cuts this occult arch make another prick to repreſent the Latitude you are arived to; ſo ſhall the Rhumb paſſing through thoſe two pricks (or that is moſt Parallel to thoſe two pricks) be as in the laſt Prob. the Courſe or the Rhumb thoſe two pricks Bears on.

The difference of Longitude you may find as by Prob. 11.

## PROB. XIV.

### *To find by the Globe the Variation of the* Needle; *commonly called the* Variation of the Compaſs.

OBſerve by a Compaſs whoſe wyer is placed juſt under the *Flower deluce*, what point of the Compaſs the Sun Riſes or Sets on, Morning, or Evening: Then examine by Prob: 10. of the ſecond Book, what degree of the Horizon the Sun Riſes or Sets on by the Globe alſo; and if the Riſing or Setting be the ſame, both on the Globe and Compaſs, there is no Variation in your Place, But if there be difference between the Riſing or Setting by the Compaſs and the Globe, then is there Variation in your Place.

If the point the Sun Riſes upon in the Compaſs be neerer the North point, then the point the Sun Riſes upon by the Globe, the Variation is Weſtwards.

If the point the Sun Sets upon in the Compaſs be neerer the North then the point it Sets upon by the Globe, the Variation is Eaſtwards.

If the point the Sun Sets upon in the Compaſs be further from the North point, then the point the Sun Sets upon by the Globe, the Variation is Weſtwards.

If the point the Sun Riſes upon in the Compaſs be further from the North point then the point the Sun Riſes upon by the Globe, the Variation is Eaſtwards. And ſo many degrees as there is between the point of Riſing or Setting found by the Compaſs, and the point of true Riſing or Setting found by the Globe, ſo

many degrees is the Variation from the North towards the East, or West point.

### *Otherwise, when the Sun hath* Altitude.

Having the Altitude of the Sun; find by Prob. 22. of the second Book, its *Azimuth*: Then examine by a Compass whether the true *Azimuth* found by the Globe, agree with the *Azimuth* found by a Nautical Compass: If they agree there is no Variation: But if the *Azimuth* of the Compass before Noon be neerer the North then the true *Azimuth* found by the Globe, the Variation is Westwards.

If the *Azimuth* by the Compass Afternoon be neerer the North, the Variation is Eastwards.

If the *Azimuth* by the Compass Afternoon be further from the North, the Variation is Westwards,

If the *Azimuth* by the Compass before Noon be further from the North, the Variation is Eastwards.

And this Variation shall be as aforesaid so many degrees as there is between the *Azimuth* Observed by the Compass, and the true *Azimuth*, Observed by the Globe.

## Prob. XV.

### *To keep a* Journal *by the* Globe.

BY some of these foregoing Problemes you may Dayly (when Observations can be made) find both the Longitude and Latitude on the Globe of the Places you are arrived to, and also the Way the Ship hath made, and make pricks on the Globe in their proper Places for every Daies Journey, so truly and so naturally that if you kept your reckoning aright you may be sure you cannot miss any thing of the truth it self; and that with less trouble and greater advantage, then keeping a Book of every Daies Reckoning.

Prob.

## PROB. XVI.

### *To* Steer *in the* Night *by the* Stars.

REctifie the Globe and Hour Index as by Prob. 2. of the laſt Book, and turn about the Globe till the Index of the Hour Circle points to the Hour of the Day or Night: Then turn the Globe till the Difference of Longitude between the Place you depart from, and the Place you ſail to paſs through the Meridian; and if any Star in the Latitude of the Place you ſail To come to the Meridian, or neer the Meridian with the degree of the difference of Longitude, that Star is at that time in or neer the *Zenith* of that Place you ſail to: and by finding the ſame Star in Heaven, as by Prob. 44. of the laſt Book you may direct your ſhip towards that Star, and ſail as confidently (ſaies Mr *Blagrave*) as if *Mercurie* were your Guide. But becauſe this Star moves from the *Zenith* of this Place, you muſt often examine what Star is come to the *Zenith*, and ſo often change the Star you Steer by, as the length of your Voyage may require.

## PROB. XVII.

### *How to platt on the* Globe *a New Land, never before Diſcovered.*

THeſe two following Problemes are 2. Chapters of Mr *Wrights*, delivered by him as follows.

It may ſometimes fall out in new Diſcoveries, or when your Ship by means of a Tempeſt is driven out of her right Courſe, that you ſhall come to the ſight of ſome Iſle, Shoald, or new Land, whereof the Mariner is utterly ignorant: And to make ſome relation of the ſame, or to go unto it ſome other time, if you deſire to ſet it down on your Globe in the true place, you may do it after this manner: So ſoon as you have ſight thereof, mark it well firſt with your Compaſs, obſerving diligently upon which Point thereof it lieth. And ſecondly, you muſt there take the heigth of the Sun, or of the Pole-ſtar, as you were taught Prob. 13. of the ſecond Book, that you may know in

in what Point your Ship is, and that point you muſt call the Firſt Point; which being ſo done, your Ship may ſail on her Courſe all that day, till the day following, without loſing her Way: and the next day mark the Land again, and ſee upon what Point it lieth; and then take your heigth, and with it caſt your Point of Traverſe once again; and that you may call your ſecond Point. Then take a pair of Compaſſes, and placing one foot upon the Firſt Point, and the other upon the Rhumb towards which the Land did Bear, when you Caſt your Firſt Point: ſet alſo one foot of another pair of Compaſſes in the ſecond Point, and the other foot upon the Rhumb upon which the Land lay when you caſt your ſecond Point; and theſe two Compaſſes thus opened, you muſt move by their Rhumbs, till thoſe two feet of both Compaſſes do meet together, which were moved from the foreſaid two Points: and where they do ſo meet together, there may you ſay is the Land which you Diſcovered; which Land you may point out with the In-lets and Out-lets, or Capes and other Signes, which you ſaw thereupon. And by the graduation you may ſee the Latitude thereof; that thereby you may find it, if at any time after you go to ſeek for it.

## Prob. XVIII.

*Seeing two known* Points *or* Capes *of Land, as you ſail along, how to know the diſtance of your Ship from them.*

Pitch one foot of one pair of Compaſſes upon one of the two foreſaid Capes, and the other foot upon the Rhumb which in this Compaſs pointeth towards that Cape. And in like manner ſhall you do with another pair of Compaſſes, placing one foot thereof upon the other known Cape, and the other foot upon the Rhumb, which ſtretcheth towards the ſaid ſecond Cape; and moving the two Compaſſes (ſo opened) by theſe two Rhumbs off from the Land, the very ſame Point where the two feet which came from the two Capes do meet, you may affirm to be the very Point where your Ship is. And then meaſuring by the degrees of the Equinoctial, you may ſee what diſtance there is from the ſaid Point to either of the foreſaid Capes, or to any other place, which you think good, for it is a very eaſie matter, if you know the point where your Ship is.

Prob.

## Prob. XIX.

### *Of* Tides, *and how by help of the* Globe *you may in general judge of them.*

Divide the Equinoctial into 30 equal parts, as was directed in Prob. 54. of the laſt Book. Theſe 30. equal parts repreſent the 30. daies of the Moons Age.

Then on the North and South point of the Compaſs in the outmoſt Verge of the Horizon, Write with red Ink 12. From the North Eaſtward, *viz.* at the Point North and by Eaſt, Write 11 $\frac{1}{4}$. At the next point to that the ſame way, *viz.* North North Eaſt, Write 10 $\frac{1}{2}$. At the next, *viz.* North Eaſt and by North, Write 9 $\frac{3}{4}$. And ſo forward to every point of the Compaſs; rebating of the laſt hour $\frac{3}{4}$ till you come to 12. in the South; where you muſt begin again to mark that Semi-Circle alſo in the ſame order you did the laſt. In this Circle is then repreſented the Points of the Compaſs the Sun and Moon paſſeth by every Day; and the Figures annexed repreſent the twice 12. hours of Day and Night.

Having thus prepared your Globe and Horizon, you may by having the Moons Age, and the point of the Compaſs on which the Moon maketh full Sea at any Place given, find at what Hour of Day or Night it ſhall be high Tide in the ſame Place. Thus,

It is a known Rule that a North and South Moon makes high water at *Margarate*. Therefore Bring the firſt point of ♈ to the North or South point in the Horizon, and Elevate the North Pole into the *Zenith*: Then count in the Equinoctial the Daies of the Moons Age numbred in red figures; and the Hour and minutes (written in red figures annexed to the names of the Windes) that ſtands againſt the Moons Age ſhall be the Hour of High Tide on that Day or Night at *Margarate*.

*The End of the Third Book.*

# The Fourth BOOK,

*Shewing the Practical Use of the*

# GLOBES:

*Applying them to the Solution of*

# Astrological Problemes.

## PRÆFACE.

THe *Practise of* Astrology *is grounded upon a two-fold Doctrine. The first, for erecting a Figure of Heaven, placing the Planets in it, finding what Aspects they bear each other, and in what Places they are constituted, &c. and this we call the* Astronomical *part of* Astrology.

*The second is, how to judge of the events of things by the Figure erected: and this is indeed the only* Astrological *part.*

*The first of these I shall briefly handle; because what therein is proposed may be performed by the Globe, both with speed, ease, delight, and demonstration. The second I shall not meddle with, but refer you to the whole Volumnes already written upon that Subject.*

PROB.

## Prob. I.

### *To Erect a Figure of the* 12 Houſes *of* Heaven.

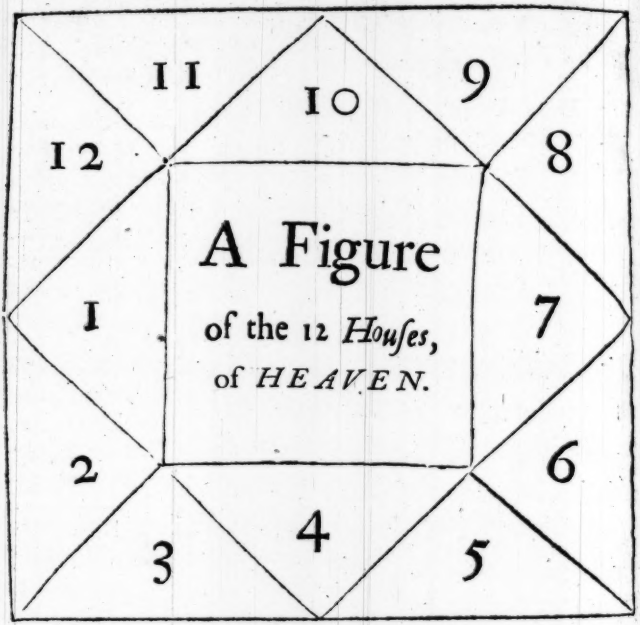
BEfore you erect a Figure of the 12 Houſes of Heaven it will be requiſite you place the Planets, ☽, and ☿, according to their Longitude and Lattitude upon the Globe, as was directed in Prob. 55. of the ſecond Book: for then, as you divide the Houſes of your Figure by the Circle of Poſition, you may by inſpection behold in what Houſes the Planets are ſituated, and alſo ſee what fixed Stars they are applying to, or ſeparating from. But to the matter.

There is diſagreement between the Ancient and Modern Aſtrologers, about erecting a Figure of Heaven. Mr *Palmer* in his Book of *Spherical Problemes* Chap. 48. mentions four ſeveral waies, and the Authors that uſed them; whereof one of them is called *the Rational way* uſed by *Regiomontanus*; and now generally practiſed by all the Aſtrologers of this Age. This way the face of Heaven is divided into twelve parts, which are called the twelve Houſes of Heaven, numbred from the Aſcendent or angle at Eaſt downwards, with 1, 2, 3, &c, As in the following Figure.

In a Direct Sphear, *viz.* under the Equator theſe twelve Houſes are twelve equal parts: but in an Oblique Sphear they are unequal parts, and that more or leſs according to the quantity of the Sphears obliquity.

Theſe twelve Houſes are divided by 12. Semi-Circles of Poſition; which are Semi-Circles paſſing from the two interſections of the Horizon and Meridian through any Star, degree, or point in the Heavens.

Four of theſe Houſes are named Cardinals. The firſt and moſt eminent of theſe Cardinals is the firſt Houſe, or the Angle of Eaſt, called the Aſcendent; where the Semi-Circle of Poſition is the ſame with the Eaſtern Semi-Circle of the Horizon. The ſecond Cardinal is the tenth Houſe, or the Angle of South; called *Medium Cæli*, or *Culmen Cæli*; where the Semi-Circle of Poſition is the ſame with the Semi-Circle of the Meridian above the Horizon. The third Cardinal is the ſeventh Houſe, or the Angle of Weſt; called the Deſcendent; where the Semi-Circle of Poſition is the ſame with the Weſtern Semi-Circle of the Horizon.




zon. The fourth Cardinal is the fourth Houſe, or Angle of North; called *Imum Cæli*; where the Semi-Circle of Poſition is the ſame with the Semi-Circle of the Meridian under the Horizon.

The degrees and minutes of the *Ecliptick* upon the Cuſps of theſe four Houſes (that is, upon the beginning of theſe Houſes) are found all at once only by bringing the Riſing degree of the *Ecliptick* to the Horizon: (for the Horizon repreſents the Cuſp of the Aſcendent:) and then ſhall the Meridian cut the degree of the *Ecliptick* on the Cuſp of the tenth Houſe. The Weſtern Semi-Circle of the Horizon ſhall cut the degree of the *Ecliptick* on the Cuſp of the Seventh Houſe: and the Semi-Circle of the Meridian under the Horizon ſhall cut the degree of the *Ecliptick* on the Cuſp of the fourth Houſe.

If you have the day of the Moneth, you may by Prob. 3. of the

the ſecond Book find the Suns Place; and if you have the Hour of the Day, you may, by firſt rectifying the Globe, as by Prob. 2. of the ſame Book, turn about the Globe till the Index of the Hour-Circle point to the ſame Hour in the Hour-Circle, and you will then at the Eaſtern Semi-Circle of the Horizon have the degree of the *Ecliptick* that is Riſing, and by Conſequence (as aforeſaid) all the Cardinal points in their reſpective places.

Now to find what degree of the *Ecliptick* occupies the Cuſps of the other eight Houſes of Heaven; Do thus, The Globe rectified, as aforeſaid, Move the Semi-Circle of Poſition upwards till 30 degrees of the Equator ſhall be contained between it and the Eaſtern Semi-Circle of the Horizon; ſo ſhall the Semi-Circle of Poſition cut in the *Ecliptick* the degree and minute of the *Ecliptick* on the Cuſp of the twelfth Houſe; and its oppoſite degree and minute in the *Ecliptick* ſhall be the Cuſp of the ſixth Houſe, (for you muſt note that if you have but the degree and minute of the *Ecliptick* upon the Cuſps of ſix of the Houſes, the oppoſite degrees and minutes of the *Ecliptick* ſhall immediately poſſeſs the Cuſp of every oppoſite Houſe.)

*Oppoſite degrees and minutes of the* Ecliptick *poſſeſs the* Cuſps *of oppoſite* Houſes.

Then move the Circle of Poſition over 30. degrees more of the Equinoctial, ſo ſhall the degree of the *Ecliptick* cut by the Circle of Poſition be the degree of the *Ecliptick*, upon the Cuſp of the eleventh Houſe; and its oppoſite degree in the *Ecliptick* ſhall be upon the Cuſp of the fifth Houſe. The degree of the *Ecliptick* upon the Cuſp of the tenth and fourth Houſes was found as before. Then remove the Circle of Poſition to the Weſtern ſide of the Meridian, and let it fall towards the Horizon till 30. degrees of the Equator are contained between the Meridian and it, ſo ſhall the degree of the *Ecliptick* cut by the Semi-Circle of Poſition be the degree of the *Ecliptick* on the Cuſp of the Ninth Houſe; and the oppoſite degree of the *Ecliptick* ſhall be upon the Cuſp of the third Houſe. Let the Semi-Circle of Poſition fall yet lower, till it paſs over 30. degrees more of the Equator, ſo ſhall the degree of the *Ecliptick* cut by the Semi-Circle of Poſition be the degree of the *Ecliptick* on the Cuſp of the eighth Houſe; and the oppoſite degree of the *Ecliptick* ſhall be upon the Cuſp of the ſecond Houſe. The degrees of the *Ecliptick* on the Cuſp of the ſeventh Houſe, and Aſcendent, were found as before.

## Example.

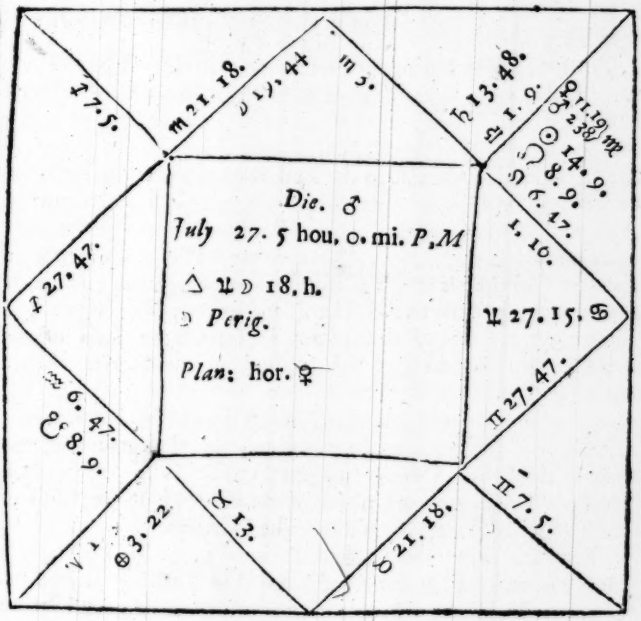
I would erect a Figure of Heaven for *July* 27. 5. hours 0. minutes Afternoon, 1658. in the Latitude of *London, viz.* 51 ½ degrees, North Latitude.

I first place the Planets, ☊, and ♃, on the Globe, as by Prob. 55. of the Second Book was directed: yet not exactly as I find them in the *Ephemeris*, for that shews only their place in the *Ecliptick* at Noon: Therefore I consider how many degrees or minutes each Planets motion is in a whole Day or 24. Hours, by substracting the *Ecliptical* degrees and minutes of the Planets place that Day at Noon from the *Ecliptical* degrees and minutes of the Planets place the next Day at Noon: or contrarily if the Planet be Retrograde: for the remains of those degrees and minutes is the motion of the Planet that Day; Therefore proportionably to that motion I place the Planet forward in the *Ecliptick*: (or backward if it be Retrograde:) As if the Sun should move forward 1 degree, that is, 60 minutes in a whole Day, or 24 Hours, then in 12 hours he should move 30 minutes, in 6 hours 15 minutes, in 4 hours 10 minutes, in 1 hour 2 ½ minutes, and so proportionably for any other space of Time: which I consider before I place the Planets on the Globe.

Having thus placed the Planets on the Globe, I Elevate the North Pole 51 ½ degrees above the Horizon, and find the Suns place by Prob. 3. Book 2. to be in ♌ 14. degrees 9. minutes, Therefore I bring ♌ 14. degrees 9. minutes to the Meridian, and the Index of the Hour-Circle to 12. Then I turn the Globe Westwards, because it is Afternoon, till the Index point to 5. Hours afternoon, and with a quill I fasten the Globe in this position: Then I examine what degree of the *Ecliptick* is at the Ascendent or Horizon, and find ♐ 27. 47. to which Signe degree and minute ♊ 27. 47. is opposite, and therefore, as aforesaid upon the Cusp of the Seventh House: Lifting up the Circle of Position till it pass over 30 degrees of the Equator from the Horizon upwards I find ♐ 7. 5. cut by it in the *Ecliptick*, which is the Signe degree and minute upon the Cusp of the twelfth House, and its opposite Signe degree and minute is ♊ 7. 5. which is upon the Cusp of the sixth House: Then lifting up the Circle of Position again till it pass over 30 degrees more of the Equinoctial, I find

cut

cut by the Circle of Poſition ♏ 21. 18. which is the Signe degree and minute upon the Cuſp of the eleventh Houſe; and its oppoſite Signe degree and minute is ♉ 21. 18. which is upon the Cuſp of the fifth Houſe: ♏ 3. 20. is at the Meridian, which is the Cuſp of the tenth Houſe, and the Signe degree and minute oppoſite to it is ♉ 3. 20. which is on the Cuſp of the fourth Houſe. Then taking the Semi-Circle of Poſition off its Poles, I place it on the Weſt ſide the Meridian, and let it fall towards the Horizon till it paſs over 30 degrees of the Equator from the Meridian, and find the Circle of Poſition cut the *Ecliptick* in ♎ 1. 9. which is the Signe degree and minute on the Cuſp of the ninth Houſe; oppoſite to ♎ 1. 9. is ♈ 1. 9. therefore ♈ 1. 9. is upon the Cuſp of the third Houſe: Letting the Circle of Poſition fall yet lower till it paſſes over 30 degrees more of the Equator, I find it cut the *Ecliptick* in ♌ 6. 47. which is the Signe degree and minute up-




on

on the Cusp of the eighth House; and its opposite Signe degree and minute is ♒ 6. 47. which is upon the Cusp of the second House. So have you a Figure of the Face of Heaven: which if you have future use for, you may set down the several charracters in the proper places of a Figure, as they are on the other side the leaf.

## Prob. II.

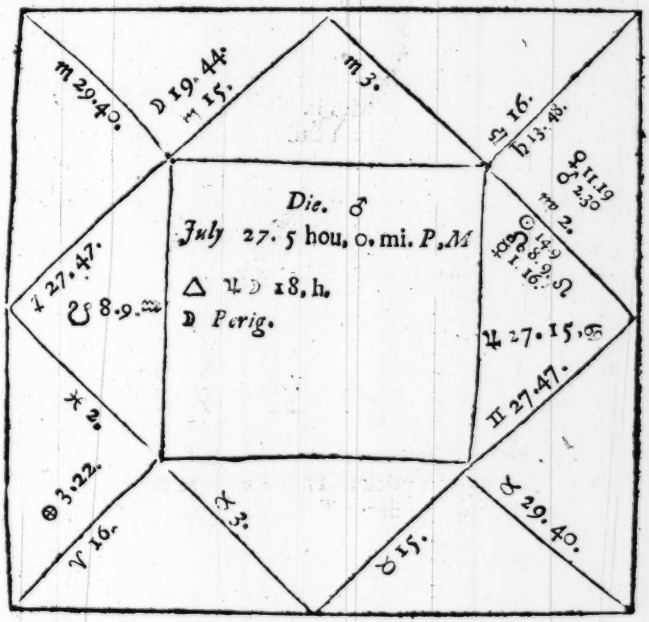
### *To Erect a Figure of* Heaven *according to* Campanus.

*Regiomontanus* as aforesaid makes the beginning of every House to be the Semi Circle drawn by the side of the Semi Circle of Position according to the succession of every 30th degree of the Equator from the Horizon. But *Campanus* makes it to be the Semi-Circle drawn by the side of the Semi-Circle of Position according to the succession of every 30th degree of the *Prime Vertical*, or East *Azimuth*; which is represented by the Quadrant of Altitude placed at the East point.

The four Cardinals are the same, both according to *Regiomontanus*, and *Campanus:* but the other eight Houses differ: Therefore when you would find them according to *Campanus*; Rectifie the Globe and Quadrant of Altitude, and bring the lower end of the Quadrant of Altitude to the East point in the Horizon: Then count from the Horizon upwards 30 degrees on the Quadrant of Altitude, and bringing the Circle of Position to those 30 degrees, examine where the Circle of Position cuts the *Ecliptick*, which at the aforesaid time is in ♏ 29. 40 for that degree and minute is upon the Cusp of the twelfth House, and its opposite degree and minute in the *Ecliptick viz.* ♉ 29. 40. is upon the Cusp of the sixth House: Lift up the Circle of Position 30 degrees higher upon the Quadrant of Altitude (*viz.* to 60 degrees) and the Circle of Position will cut the *Ecliptick* in ♏ 15. degrees for the Cusp of the eleventh House. and its opposite degree and minute in the *Ecliptick viz.* ♉ 15. is upon the Cusp of the fifth House. The degree and minute of the *Ecliptick* on the Cusp of the Tenth and Fourth Houses is at the Meridian.

Then transfering the Circle of Position to the West side of the Meridian and the Quadrant of Altitude to the West point in the Horizon, Let the Semi-Circle of Position fall 30 degrees from the Meridian on the Quadrant of Altitude, and it will cut in the *Ecliptick*

*cliptick* ♎ 16 degrees, for the Cusp of the ninth House, and its opposite degree and minute in the *Ecliptick viz.* ♈ 16. is upon the Cusp of the third House: Let fall the Circle of Position 30 degrees lower on the Quadrant of Altitude, and it will cut the *Ecliptick* in ♏ 2 degrees, for the Cusp of the eight House, and its opposite degree *viz.* ♓ 2. degrees is on the Cusp of the second House: The Cusps of the Seventh and Ascendent is the same with *Regiomontanus viz.* ♊ 27. 47, and ♐ 27. 47. The Figure follows.




## Prob. III.

### *To find the length of a* Planetary Hour.

*Astrologers* divide the Artificial day (be it long or short) into 12 equal parts, and the Night into 12 equal parts: These parts they call Planetary Hours. The

first of these Planetary Hours takes its denomination from the Planetary Day; and the rest are named orderly from that Planet, according to the succession of the Planetary Orbs: As if it be Munday that is, the Moons day, (as by Prob. 42. of the second Book) the Planet reigning the first Hour shall be ☽, the Planet ruling the second Hour shall be ☿, the third Planetary Hour shall be ♀, the fourth ♂, the fifth ☉, the sixth ♃, the seventh ♄: Then begin again with ☽ for the eight Planetary, ☿ for the ninth and so through the whole Day and Night, till the Sun Rise again the next Day.

The length of this Planetary Hour is found by the Globe, thus: The Globe rectified; Bring the Suns place to the East side the Horizon, and make a prick at the degree of the Equator that comes to the Horizon with it. Then remove the Suns place to the Meridian, and count the number of degrees of the Equator comprehended between that prick and the degree now at the Horizon; and divide that number of degrees and minutes by 6. because there is 6 Planetary Hours past since Noon; and the Quotient shall shew the number of degrees and minutes that pass through the Meridian in one Planetary Hour.

## Example.

*July* 27. 1658. I would know the length of the Planetary Hour here at *London*: I Rectifie the Globe, and bring the Suns place *viz* ♌ 13. 50. to the Eastern side the Horizon, and find 115 degrees of the Equator come to the Horizon with it; to this 115 degrees I make a prick: Then I turn the Suns place to the Meridian, and find 226 degrees of the Equator at the Horizon, Therefore I either count the number of degrees between the pricks and the degree of the Equator at the Horizon, or else substract the lesser from the greater, but both waies I find 111 degrees of the Equator to pass through the Meridian (or the Horizon) in six Planetary Hours. Therefore dividing 111. by 6. I find 18. degrees 30 minutes of the Equator to pass through the Meridian in one Planetary Hour: which 18. degrees 30 minutes reduced into Time, yeelds 72. minutes, by accounting for every 15. degrees one Hour, for 1. degree 4 minutes, and for half a degree 2. minutes of Time. and so proportionably: so that the length of a Planetary Hour, *July* 27 is 1 common Hour and 12 minutes here at *London*.

PROB.

## Prob. IV.

*The length of a* Planetary Hour *known, to find what* Planet *Reigneth any given* Hour *of the* Day, *or Night.*

The Globe Rectified as in the last Probleme, Turn about the Globe till the Index of the Hour Circle points to the Hour of the Day in the Hour Circle. Then count the number of degrees comprehended between the degree of the Equator at the Horizon and the prick in the Equator, made as in the last Probleme, and reduce that number of degrees into minutes of Time, by reckoning 4. minutes of Time for every degree of the Equator. Reduce also the number of degrees and minutes that pass through the Meridian in one Planetary Hour into minutes, by allowing (as aforesaid) 4. minutes for every degree, and then divide the first number by the second and the Quotient shall be the number of Planetary Hours since Sun Rising. Having the number of Planetary Hours since Sun Rising. Reckon the first Planetary Hour by the name of that Planet that bears the denomination of the Day. the second Planetary Hour by the Planet succeeding that in order. the third by the next in order, and so for all the rest till you come to the last Planet *viz.* ♄, and then begin again with ☉, and so to ☽ &c. till you have reckoned so many Planets as there are Planetary Hours since Morning: and that Planet the number ends on shall be the Planet Reigning that Planetary Hour.

### Example.

*July* 27. 1658. aforesaid, I would know what Planet Rules at 5 a clock past Noon: The length of the Planetary Hour this Day found by the last Probleme is 1. hour 14. minutes: Therefore the Globe Rectified, I bring the Index of the Hour Circle to the Hour of the Day *viz.* 5 a clock in the Hour-Circle, and then count the number of degrees between the Prick made, as by the last Probleme and the degree of the Equator at the Horizon; and find them 187. which I reduce into minutes, by allowing for every degree 4 minutes; and that gives 748 minutes. This 748 minutes I divide by the minutes contained in one Planeta-

ry Hour this Day, *viz.* by 72. and find 10. hours 8. minutes; which shews there are 10. Planetary Hours and 8. minutes past and gon since Sun Rising. Therefore ♂ being the Planet after whose name the Day is called *viz. Dia Martis*, ♂ is as aforesaid, the Ruler of the first Planetary Hour: From him I count the Planet succeeding, which is ☉ for the second Hour; from ☉ I count the Planet succeeding, which is ♀ for the third Hour, and so on to ☿, and ☽: and then I begin the Round again with ♄, ♃, ♂, and ☉, till I come again to ♀, which is the tenth Planetary Hour since Sun Rising: and the minutes remaining being 8. shews that there is 8. minutes past since she began to Reign.

## Prob. V.

### *To find* Part *of* Fortune *by the* Globe.

COunt the number of degrees and minutes contained between the Suns place and the Moons place, begining at the Suns place and counting according to the succession of Signes till you come to the Moons place: and having found that number of degrees and minutes, add them to the number of degrees and minutes Ascending, reckoned from the first point of ♈. If the sum exceed 360, cast away 360, and the remainder shall be the number of degrees and minutes from the first point in ♈, in which *Part of Fortune* falls. But if it do not exceed 360, you have already the number of degrees and minutes from the first point of ♈ in which you must place *Part of Fortune*.

### Example.

I would find the place of *Part of Fortune* for the time of our Figure: I seek the two pricks representing ☉ and ☽, and find ☉ in ♌ 14. 9. and ☽ in ♏ 19. 44. therefore counting from the Suns place to the Moons place according to the succession of Signes, I find 95. degrees 35. minutes, contained between them: This 95. degrees 35. minutes I add to 267. degrees 47. minutes, the degree and minute contained between the first point of ♈ and the Ascendent; and they make together 363. degrees 22. minutes. This exceeds 360. therefore I cast away 360. and the remains are 3 degrees 22. minutes, for the place in the *Ecliptick* of *Part of Fortune*, reckoned from the first point of ♈.

Therefore

Therefore this character ⊕ which represents *Part of Fortune*, I set in its proper place of the Figure, as I did the Planets.

## Prob. VI.

### *To find in what* Circle *of* Position *any* Star, *or any degree of the* Ecliptick *is.*

Circles of Position are numbred from the Horizon upwards, upon the Quadrant of Altitude placed at the East or West point of the Horizon. Therefore when you would find what Circle of Position any Star or degree of the *Ecliptick* is in, Rectifie the Globe and Quadrant of Altitude, and bring the lower end of the Quadrant of Altitude to the East or West point of the Horizon, and lift up the Circle of Position till it come to the Star or degree of the *Ecliptick* proposed: and the number of degrees the Circle of Position then cuts in the Quadrant of Altitude is the number of the Circle of Position that the Star or degree of the *Ecliptick* is in. If the Star or degree of the *Ecliptick* be under the Horizon, turn the Globe about till 180. degrees of the Equator pass through the Meridian, then will the Star or degree of the *Ecliptick* be above the Horizon: Lift up then the Circle of Position (as before) to the Star or degree of the *Ecliptick*: and the number of degrees of the Quadrant of Altitude the Circle of Position cuts on the East side, is the number of Circles of Position the Star was under the Horizon on the West side: Or so many degrees as the Circle of Position cuts on the Quadrant of Altitude in the West side the Horizon is the number of the Circles of Position the Star or degree of the *Ecliptick* was under the Horizon on the East side.

## Prob. VII.

### *To find the* Right Ascensions, *the* Oblique Ascensions, *and the* Declinations *of the* Planets.

Examine the Right Ascensions and Declinations of those pricks made to represent each Planet, in Prob. 1. of this Book; and work by them as you were directed to work by the Sun, in Prob. 26, 27, 28. of the second Book.

## Prob. VIII.

### *How to* Direct *a* Figure, *by the* Globe.

TO Direct a Figure is to examine how many degrees of the Equinoctial are moved Eastwards or Westwards, while any Planet or Star in one House comes to the Cusp or any other point of any other House.

When you would Direct any *Promittor* to any *Hylegiacal* point examine the degree of the Equator at the Meridian; then turn about the Globe till the *Promittor* come to the *Hylegiacal* point, and examine again the degree of the Equator at the Meridian: and by substracting the lesser from the greater, you will have the number of Degrees that passed through the Meridian, whiles the place of the *Promittor* was brought to the *Hylegiacal* point: and that number of degrees shall be the Arch of Direction.

### Example.

I would Direct the Body of the Moon in our Figure aforesaid to *Medium Cæli*, or the tenth House: I find by the Globe 203. degrees 30. minutes of the Equator at the Meridian with the tenth House, and turning the Globe till the prick made to represent the Moon come to the Meridian, I find 227. degrees 20. minutes of the Equator come to the Meridian with it. Therefore I substract the lesser from the greater *viz.* 203 degrees 30 minutes from 227. degrees 20. minutes, and have remaining 23 degrees 50 minutes.

This 23. degrees 50. minutes shews that 23. Years 10. Moneths must expire ere the Effects promised by the Moons present position shall opperate upon the signification of the tenth House.

If the Body of the Moon had been Directed to any other point then the Meridian or Horizon; you must have Elevated the Circle of Position to the point proposed; and have under-propped it to that Elevation, and then have turned about the Globe till the prick representing the Moon, had come to the Circle of Position; and then the degrees of the Equator that should have passed through

through the Meridian whiles this motion was making, ſhould be the number of degrees of Direction; and ſignifie in Time as foreſaid.

## PROB. IX.

### *Of* Revolutions: *and how they are found by the* Globe.

BY Revolution is meant the Annual Converſion of the Sun to the ſame place he was in at the Radix of any Buſineſs.

When you would find a Revolution by the Globe, firſt find the Right Aſcenſion of Mid Heaven at the Radix of the Buſineſs, as by Prob. 26. of the ſecond Book you were directed to find the Right Aſcenſion of the Sun; and to it add 87 degrees for every Year ſince the Radix: Then ſubtract 360 ſo oft as you can from the whole and the Remains ſhall be the Right Aſcenſion of Mid Heaven for the Annual Revolution.

If you count the number of degrees of the Equator contained between the Right Aſcenſion of the Mid Heaven and the Right Aſcenſion of the Sun, and convert that number of degrees into Time, by allowing for every 15. degrees 1 Hour of Time it will ſhew if the Suns place be on the Weſtern ſide of the Meridian the number of Hours and minutes Afternoon the Revolution ſhall happen on, but if on the Eaſt ſide the Meridian, the number of Hours and minutes Before-noon the Revolution ſhall happen on.

## PROB. X.

### *How a Figure of* Heaven *may be erected by the* Revolution *thus found.*

SEek the degree of Right Aſcenſion of Mid Heaven, and bring it to the Meridian, ſo ſhall the four Cardinal points of the Globe be the ſame with the four Cardinal points in Heaven at the time of the Revolution. The other Houſes are found by the Circle of Poſition: as in the firſt Probleme of this Book.

*The End of the Fourth Book.*

# The Fifth BOOK,

*Shewing the Practical Use of the*

# GLOBES:

*Applying them to the Solution of*

# Gnomonical Problemes

## PRÆFACE.

DYals *are of two sorts*, Pendent, *and* Fixed. Pendent *are such as are hung by the hand, and turned towards the Sun; that by its Beams darting through small Pin-holes made for that purpose, the hour of the Day may be found. These are of two sorts*, Vniversal, *and* Particular.

Vniversal Dyals *are those commonly called Equinoctial or Ring-Dyals: They are used by Sea-men and Travellers, that often shift Latitudes.*

Particular *are such as are made and only serve for Particular Latitudes. Of these sorts are the several Dyals described on Quadrants, Cilinders, &c.*

Fixed Dyals *shall be the matter of this discourse; and they are such as are made upon fixed Planes, and shew the Hour of the Day by a* Stile *or* Gnomon *made Parallel to the Axis of the World.*

Of

*Of the ſeveral Kinds of Dyal Plains: and how you may know them.*

A Plain in Dyalling is that flat whereon a Dyal is diſcribed.

There is ſome diſagreement among Older and Later Authors in the naming of Plains: for ſome name them according to the Great Circle in Heaven they ly in: and others according to the ſcituation of the Poles of the Plains. Thus they which name them according to the Great Circle in Heaven their Plains ly in, call that an Horizontal Plain, which others call a Vertical Plain; thoſe Vertical, which others will call Horizontal; and thoſe Polar, which others call Equinoctial.

However they be called it matters not, ſo you can but diſtinguiſh their kinds, which with a little conſideration you may eaſily learn to do: For remembring but upon what grounds either the Older or Later Authors gave the Plains their Names, upon the ſame grounds you may alſo learn to know them. I confeſs both wayes admit of ſome juſt exception againſt for in the Older Rule a Plain about the Pole, is called an Equinoctial Plain; when as to a ſudden apprehenſion it would ſound more ſignificant to call it a Polar Plain, as Later Authors do: Again, Later Authors call an Horizontall Plain a Vertical Plain; when as it ſounds more ſignificant to call it an Horizontal Plain, as Older Authors do: becauſe it lie flat upon the Horizon: But I ſhall give you the names according to both Rules, and leave you to your liberty to accept of which you pleaſe.

Firſt therefore, you have an Equinoctial Plain, otherwiſe called a Polar Plain. This Plain hath two Faces, upper, and under: Theſe two Faces ly in the Plain of the Equinoctial: the upper Face beholding the Elevated Pole, the under Face the depreſſed Pole.

2. An Horizontal Plain, otherwiſe called a Vertical Plain: it lies in the Plain of the Horizon, directly beholding the *Zenith*.

Erect Plains, otherwiſe called Horizontal Plains, are the ſides of Walls, and theſe are of ſeven ſorts, *viz.* 1. Erect Direct Vertical, North or South, 2. Erect Direct, Eaſt or Weſt. 3. Erect Vertical Declining. 4. Erect Inclining Direct. 5. Erect Inclining Declining. 6. Erect Reclining Direct. 7. Erect Reclining Declining.

3. Erect Vertical, North or South Direct, otherwiſe called

Direct North or South Horizontals, behold the North or South Directly, and ly in the East or West *Azimuth*.

4. Erect Direct East or West, otherwise called Direct East or West Equinoctials, behold the East or West Directly, and lies in the Plain of the Meridian, having its Poles in the Equinoctial.

5. Erect Vertical Declining Plains, otherwise called Declining Horizontals, do not behold the North or South Directly, but swerves from them so much as the *Azimuth* Parallel to their Plains swerves or Declines from them.

6. Erect Inclining Direct Plains, have the upper side of their Plains Inclining or coming towards you, and their Plains do exactly behold either the East, West, North, or South.

7. Erect Reclining Direct Plains, have the upper side of their Plains Reclining or falling from you, and their Plains exactly beholding either the East, West, North, or South.

8. Erect Reclining Declining, or Erect Inclining Declining Plains, are those Plains which are either Inclining or Reclining, but do not behold the East, West, North, or South, Directly but swerve or Decline more or less from them.

9. Polar Plains are Parallel to the Axis of the World, and to the Meridians that cuts the East and West, or North and South, points of the Horizon.

All these kinds of Plains have two Faces; the one beholding the North Pole with the same respect that the other beholds the South Pole; except the Equinoctial Plain, which, because neither Pole is Elevated, hath but one Face: yet that one contains as many Hour lines as two other Faces.

These two Faces or Plains will receive just 24. hour lines, for the 24 Hour-lines of Day and Night: for so much as the one side or Face wanteth or exceedeth 12. the other side shall either exceed or want of 12.

Every Dyal Plain is Parallel to the Horizon of some Country or other in the World: therefore a Dyal made for any Horizon in the World may be set to such a Position that it will shew you the Hour of the Day in your own Habitation: At least for so long as the Sun continues upon that Plane.

All Plains may be aptly demonstrated by the Globe, by setting it correspondent to all the Circles in Heaven, as by Prob. 2. of the second Book: for if you imagine the Globe in that Position were prest flat into the Plain of any Circle, that Flat shall represent

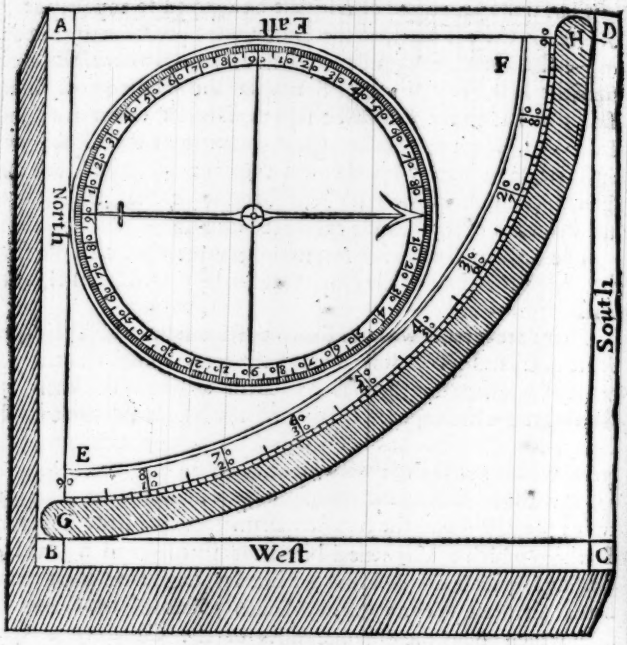
represent a Dyal plain, which shall be called after the name of that Circle it is prest into.

Thus if the Quadrant of Altitude be applyed to any degree of *Azimuth*, and you imagine the Globe were prest flat to the edge of the Quadrant of Altitude, so much as that *Azimuth* Declines from the East, West, North, or South, in the Horizon, so much shall that flat on the Globe be said to Decline either from the East, West, North, or South. Or if you imagine the Globe were prest flat down even with the Plain of the Horizon, that flat shall represent an Horizontal Plain; because as was said before, the Plain lies in that Circle cal'd the Horizon.

The *Style* or *Gnomon* is that straight wyre that casts the shadow upon the Hour of the Day: it is alwaies placed Parallel to the Axis of the World.

There are several waies to find the scituation of all Plains; but the readiest and speediest is by a Clinatory. The Clinatory is made of a square board, as A B C D, of a good thickness, and the larger the better; between two of the sides is discribed on the Center A a Quadrant as E F divided into 90 equal parts or degrees, which are figured with 10, 20, 30, to 90; and then back again with the Complements of the same numbers to 90: between the *Limb* and the two Semidiameters is made a Round Box, into which a Magnetical Needle is fitted; and a Card of the Sea Compass, divided into 4 Nineties, beginning their numbers at the East, West, North, and South points of the Compass, from which points the opposite sides of the Clinatory receives their Names of East, West, North, or South. Upon the Center A whereon the Quadrant was discribed is fastned a Plumb-line, having a Plumbet of Lead or Brass fastned to the end of it, which Plumb-line is of such length that the Plumbet may fall just into the Grove G H below the Quadrant, which is for that purpose made of such a depth that the Plumbet may ride freely within it, without stopping at the sides of it. See the Figure annexed.

With this Clinatory you may examine the scituation of Plains. As if your Plain be Horizontal; it is Direct: and then for the true scituating your Dyal you have only the true North and South line to find: which is done only with setting the Clinatory flat down upon the Plain, and turning it towards the right or left hand, till you can bring the North point of the Needle to hang




just over the Flower-de-luce; for then if you draw a line by either of the sides Parallel to the Needle, that line shall be a North and South line. But herein respect must be had to the Variation of the Compass in the Place you make your Dyal: for if the North point of the Needle swerves from the North point of the World, then have you not a true North and South line. But if in your Place there be no Variation of the North point of the Needle from the North point of the World (as now it happens here at *London*) then the line drawn by the side of the Clinatory (as aforesaid) shall be a true North and South line.

But admit there be Variation, Having by Prob. 19. of the third Book found the number of degrees of this Variation towards the East or West, count the same number of degrees from the

the North point in the Card either to the Eastwards or Westwards, and note the degree in the Card terminating at that number, for that degree shall be the North point; and its opposite degree the South point: 90. degrees from it either way shall be the East and West points.

Therefore, whereas before you were directed to turn the Clinatory till the North point of the Needle point to the Flower-de-luce on the Card you must now turn (or move) the Clinatory till the North point of the Needle hang just over the degree of Variation thus found; and then a line drawn as aforesaid, by the side of the Clinatory Parallel to the Needle shall be a North and South line or (to speak more properly) a Meridional line.

You may find a Meridian line several other waies; as first; If the Sun shine just at Noon, hold up a Plumb-line so as the shadow of it may fall upon your Plain; and that shadow shall be a Meridian line.

Secondly, on the backside the Clinatory discribe a Circle, and draw a line through the Center to both sides the Circumference; cross this line with an other line at Right Angles in the Center, so shall the Circle be divided into four equal parts. These four parts you must mark with East, West, North, South; and divide each of them into 90. degrees. In the Center of this Plain erect a straight wyer prependicularly: when you would find a Meridian line examine by the tenth Prob. of the second Book the Amplitude of the Suns Rising or Setting from the East or West points, and waiting the just Rising or Setting that Day, turn the Instrument about till the shadow of the wyer falls upon the same degree from the East or West the Amplitude is of, for then the North and South line in the Instrument will be the same with the North and South line in Heaven.

Thirdly by the Suns *Azimuth*: Find the *Azimuth* of the Sun by Prob. 22. of the second Book: and at the same instant turn the Instrument till the shadow of the wyer fall upon the degree on the Instrument opposite to the degree of the Suns *Azimuth*, so shall the Meridional line of the Instrument agree with the Meridional line in Heaven.

You may the same way work by the *Azimuth* of any Star. Only, whereas the shadow of the wyer should fall upon the opposite degree aforesaid: Now you must place a Sight or Perpendicular upon that opposite degree, and turn the Instrument a-

bout till the wyer at the Center, the Sight in the oppoſite degree of the Stars *Azimuth*, and the Star in Heaven, come into one ſtraight line, ſo ſhall the Meridian line of the Inſtrument agree with the Meridional line in Heaven.

Fourthly, It may be found by any Star obſerved in the Meridian, if two Perpendiculars be erected in the Meridian line of your Inſtrument, for then by turning the Inſtrument till the two Perpendiculars and the Star come into a ſtraight line, the Meridian line of your Inſtrument will be the ſame with the Meridian line in Heaven. See more waies in Mr. *Palmer* on the *Planiſphere* Book 4. Chap. 9.

If your Plain either Recline or Incline, apply one of the ſides of your Clinatory Parallel to one of the Semi-diameters of the Quadrant to the Plain, in ſuch ſort that the Plumb-line hanging at liberty may fall upon the Circumference of the Quadrant, for then the number of degrees of the Quadrant comprehended between the ſide of the Quadrant Parallel to the Plain, and the Plumb-line ſhall be the number of degrees of Reclination, if the Center of the Quadrant points upwards, or Inclination if the Center points downwards.

If your Reclining or Inclining Plain Decline, draw upon it a line Parallel to the Horizon, which you may do by applying the back-ſide of the Clinatory, and raiſing or depreſſing the Center of the Quadrant till the Plumb-line hang juſt upon one of the Semi-diameters, for then you may by the upper ſide of the Clinatory draw an Horizontal line if the Plain Incline, or by the under ſide if it Recline. If it neither Incline or Recline, you may draw an Horizontal line both by the upper and under ſides of the Clinatory. Having drawn the Horizontal line, apply the North ſide of the Clinatory to it, and if the North end of the Needle points directly towards the Plain, it is then a South Plain. If the North point of the Needle points directly from the Plain, it is a North plain: but if it points towards the Eaſt, it is an Eaſt Plain: if towards the Weſt, a Weſt Plain. If it do not point directly either Eaſt, Weſt, North, or South, then ſo many degrees as the Needle declines from any of theſe four points to any of the other of theſe four points, ſo many degrees is the Declination of the Plain, with reſpect (as aforeſaid) had to the Variation of the Compaſs.

Or if you find the *Azimuth* of the Sun by its Altitude obſerved juſt when its beams are coming on or going off your

Plain,

Plain, that *Azimuth* ſhall be the *Azimuth* of your Plain.

Or you may erect a wyer Perpendicularly on your Plain, and wait till the ſhadow of that wyer comes to be Perpendicular with the Horizon, which you may examine by applying a Plumb-line to it, for then the ſhadow of the Plumb-line and the ſhadow of the Perpendicular will be in one: then taking the Altitude of the Sun you may by Prob. 22. of the ſecond Book find its *Azimuth*, and thereby know in what *Azimuth* the Plain of your Dyal lies: for the *Azimuth* your Plain lies in is diſtant from the *Azimuth* of the Sun juſt 90. degrees.

## Prob. I.

### *How by one poſition of the* Globe *to find the diſtances of the* Hour-lines *on all manner of Plains.*

You may have Meridian lines drawn from Pole to Pole through every 15. degrees of the Equinoctial, to repreſent the Horary motion of the Sun both Day and Night; and when the Pole of the Globe is Elevated to the height of the Pole in any Place and one of theſe Meridian lines be brought to the Brazen Meridian, all the reſt of the Meridian lines ſhall cut any Circle which you intend ſhall repreſent the Plain of a Dyal in the number of degrees on the ſame Circle that each reſpective Hour-line is diſtant from the Noon-line point in the ſame Circle.

Thus if you ſhould enquire the diſtance of the Hour-lines upon an Horizontal Plain in *Londons* Latitude; The Pole of the Globe (as aforeſaid) muſt be Elevated 51 ½ degrees, and one of the Meridian lines (you may chuſe the Vernal Colure) be brought to the Brazen Meridian, which being done, you are only to examine in the Horizon (Becauſe it is an Horizontal Plain) at what diſtance from the Meridian (which in Horizontals is the Noon-line) the ſeveral Meridians drawn on the Globe interſect the Horizon, for that diſtance in degrees ſhall be the diſtance on a Circle divided into 360. degrees that each reſpective Hour-line muſt have from the Meridian or a Noon line choſen in the ſame Circle; and lines drawn from the Center of that Circle through thoſe degrees ſhall be the Hour lines of an Horizontal Plain.

If it be an Erect Direct South Dyal you enquire after; Keeping

ing the Globe in its former position, apply the Quadrant of Alti-
tude to the *Zenith*, and its lower end to the East point of the
Horizon, for then as was shewed in the *Preface*) by imagining the
Globe to be prest flat to the graduated edge of the Quadrant of
Altitude, that flat shall be a South Plain and the number of de-
grees the Meridians cuts in the Quadrant of Altitude numbered
from the *Zenith* downwards shall be the number of degrees
that each Hour line shall be distant from the Meridian or Noon-
line in a Circle of 360. degrees, and lines drawn from the Cen-
ter of that Circle through those degrees shall be the Hour lines
of half the Day: the Hour lines for the other half of the Day are
of the same distance from the Noon-line, with these; only they
must be placed on the other side the Noon line.

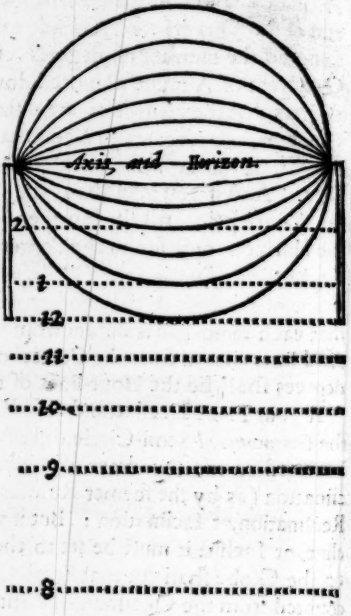
If your Plain be not Direct but declines East or West, you
must number the Declination Eastwards or Westwards re-
pectively in the degrees of the Horizon and (the Quadrant of
Altitud

Altitude ſcrewed to the *Zenith*, (as aforeſaid) bring the lower end of the Quadrant of Altitude to the ſaid degrees of Declination, and the number of degrees cut by the Meridians in the Quadrant of Altitude numbred downwards, is the number of degrees that the Hour-lines are diſtant from the Noon line in a Circle of 360. degrees: And lines drawn from the Center of that Circle through thoſe degrees be the Hour lines of half the Day. And if you turn about the Quadrant of Altitude upon the *Zenith* point till the lower end of it come to the degree of the Horizon oppoſite to the degree of Declination found before, the Meridian lines on the Globe (as before) ſhall cut the Quadrant of Altitude in the number of degrees (counted downward) that each Hour-line is diſtant from the other ſide the Noon-line: And lines drawn from the Center of that Circle through thoſe degrees ſhall be the Hour-lines of the other half of the Day.

If your Plane Decline, and alſo Recline or Incline, you muſt uſe the *Gnomonical* Semi-Circle, diſcribed in Prob. 12. which muſt be Elevated on the Quadrant of Altitude when it is ſet to the Declination (as by the former Rule) according to the complement of Reclination, or Inclination: But if your Plane be Direct, and Recline, or Incline, it muſt be ſet to the Meridian, and the Meridians on the Globe ſhall cut that Semi-Circle in the number of degrees counted from the Quadrant of Altitude if the Plane Declines, or from the Braſen Meridian, if it be Direct, that the ſeveral Hour lines are diſtant from a line Perpendicular to an Horizontal line, in a Circle divided into 360 degrees; And lines drawn from the Center through thoſe degrees ſhall be the Hour-lines of ſuch Reclining or Inclining Planes.

If your Plane be an Eaſt or Weſt, either Direct or Declining; or an Equinoctial Plane (for they are upon the matter all one) you may better conceive how they are to be made, then make them by the Globe. And for the help of your fancy herein, take Mr *Blagraves* conceit, who in his Book 6. Chap. 8. very properly demonſtrates the Rules for projecting the Hour-lines on theſe Planes. He propoſes to take 12. wyers bowed into exact Circles, all of equal Diameter, and ſet together at equal diſtance one from another in two oppoſite points, as in two Poles, and to have a ſtraight line to paſs from one Pole to another, as an Axis. Theſe 12 Wyers ſhall repreſent 24 Meridional Semi-Circles, Or indeed they may repreſent the Globe it ſelf, containing 24 Me-

ridional Semi-Circles to be diſcribed on the Globe, as aforeſaid; And if you place the Horizon of the Globe Horizontal, and the North and South points of the Globe towards the North and South points in Heaven, and bring one of theſe Wyer Meridians directly under the Braſen Meridian, and the Axis of this Wyer-Globe in the Plain of the Horizon, and faſten a Thred in the middle of the Axis, that thred drawn from the middle of the Axis by every one of theſe wyers ſhall, if prolonged till it touch an Eaſt and Weſt line drawn directly under or over the points *Zenith* or *Nadir*, point out on that Eaſt and Weſt line the diſtances of each Hour-line from the 12 a clock line; And lines drawn at Right Angles through that Eaſt and Weſt line, ſhall be the Hour lines of an Eaſt or Weſt Plane, or of an Equinoctial Plane.




The moving this thred from wyer to wyer repreſents the motion of the Sun, which as it paſſes over all the Meridians cauſes the ſhadow of that Meridional Semi Circle which it is directly over, and the Axis, and the Meridional Semi-Circle directly oppoſite to the upper Meridional Semi-Circle to fall all into one ſtraight line: And upon what point in the Eaſt and Weſt line (mentioned before) that ſhadow-line ſhall fall is marked out by the application of the thred as aforeſaid: and is an Hour-line on any of the foreſaid Planes.

If you underſtand this Probleme rightly, you do already know how to draw the Hour lines upon all manner of Planes, and need no further Inſtructions; yet partly fearing a raw Student ſhould not

not clearly understand these Rules, and partly doubting) because other Authors have been more Copious upon this Subject) that I should be censured to be too sparing of my pains, if I should lightly touch so eminent a Doctrine as Dyalling is: Therefore I shall more distinctly handle Dyalling by the Globe, according to the way or Method that other Authors have used, and that after so plain a manner as possibly my Genius can devise.

## PROB. II.

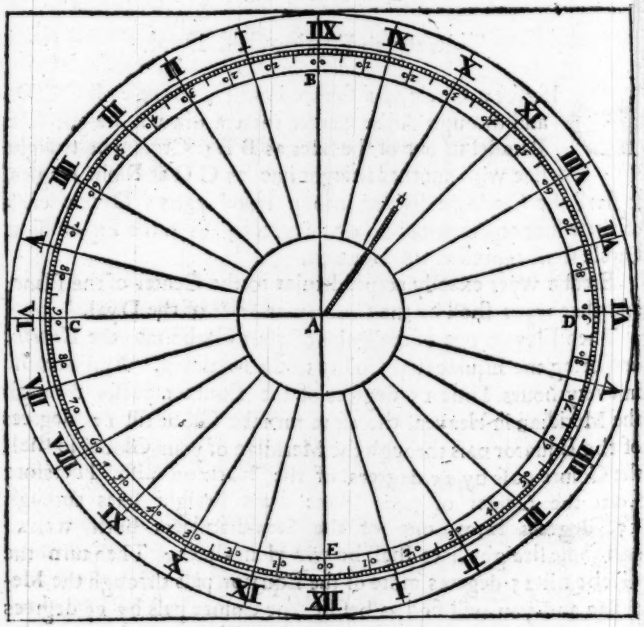
### *To make an* Equinoctial Dyal.

DIscribe a Circle, on a square board or Plane as B C E D, and through A the Center thereof draw a straight line Parallel to one of the sides, as B E; Cross that straight line with another straight line as C D at Right Angles, so shall the Circle be divided into 4 equal parts: Divide each of these four equal parts into 90. degrees; as in the Figure. This Circle shall represent the Horizon.

Erect a wyer exactly perpendicular to the Center of the Plane; and that wyer shall be the *Gnomon* or *Style* of the Dyal.

Then Elevate one of the Poles of your Globe into the *Zenith*, and bring the Equinoctial Colure to the Meridian. And because in every hours Time 15 degrees of the Equator passes through the Meridian in Heaven, therefore turn the Globe till 15 degrees of the Equator pass through the Meridian of your Globe; so shall the Colure pass by 15 degrees of the Horizon also. Therefore from the Center of your Plane draw straight lines through 15. degrees, from one of the Semidiameters both waies: and those straight lines shall be two Hour-lines: Then turn the Globe till 15 degrees more of the Equator pass through the Meridian, and you will find as before, the Colure pass by 15 degrees more of the Horizon: therefore on your Plane number 15. degrees further beyond both the former lines, and from the Center draw straight lines through both those 15. degrees, and they shall be two Hour lines more. For all the other Hour lines turn the Globe till 15. degrees of the Equator at a time pass through the Meridian, as before, and you will find that for every 15. degrees of the Equator that passes through the Meridian, the Colure will pass through 15. degrees of the Horizon: therefore those

Hour lines must be drawn from the Center according to the succession of every 15 degrees on your Plane. Having drawn the Hour lines, you may set figures to them, beginning to number your Hour lines from one of the Diameters, marking it with XII, and the next Hour line to the left hand with I, and the next II, the next III, &c. to XII. and begin again with I, II, III, &c. till you come to the other XII, where you began: and then your Dyal is finished. See the Figure.




This is an Universal Dyal, and serves in all Latitudes: therefore when you place it you must set one of the XII's downwards, and the Axis Parallel to the Axis of the World.

But note, Both faces of this Dyal ought to be divided, and the *Gnomon* must appear on both sides like the stick in a Whirligig, which childeren use; or else you must turn it upside down, so oft as the Sun passes the Equinoctial.

PROB,

## Prob. III.

### *To make an* Horizontal Dyal.

Describe a Circle on your Plane, as C B D E, and through the Center A of that Circle draw a Meridian line, as B E; croſs that line at Right angles with another line, as C D; ſo ſhall your Circle be divided into four equal parts: Divide each of theſe four parts into 90. degrees; ſo ſhall the whole be divided into 360. Theſe 360 degrees repreſent the 360 degrees of the Horizon, which a Meridian line drawn through the place of the Sun runs through in every 24. Hours: The motion of which Meridian line through the degrees of the Horizon is Regular in a Parallel Sphear; for in equal Time it moves an equal Space throughout the whole Circle, *viz.* it will paſs through 15. degrees of the Horizon in one Hours Time, (or which is all one) whiles 15. degrees of the Equator paſſes through the Meridian; as was ſhewed in the laſt Probleme: But in an Oblique Sphear its motion through the Horizon is Irregular, and that more or leſs according to the more or leſs Obliquity of the Sphear: For far Northwards or Southwards you may ſee this Meridian line paſs through 40, 50, yea 60. degrees of the Horizon in one Hours time, *viz.* whiles 15. degrees of the Equator paſſes through the Meridian: but in an other Hours time you will ſcarce have 4 or 5 degrees paſs through the Horizon whiles 15 degrees of the Equator paſſes through the Meridian.

But that you may know the motion of the Sun (repreſented by this Meridian line) through the Horizon in all Latitudes; Elevate the Pole to the Elevation of your Place, and chuſe inſtead of a Meridian line drawn through the Place of the Sun the Vernal Colure to be your Meridian line; both becauſe it is moſt viſible; and becauſe from thence the degrees of the Equator are begun to be numbred, ſo that what ſo ever decimal degree of the Equator you light on at the Meridian, or el'e where, you will find its number from that Colure already ſet down to your hand, without either adding to, or ſubſtracting from it. Bring this Colure therefore to the Meridian, and the Index of the Hour Circle to 12. in the Hour Circle. Then turn the Globe

Westwards, and so oft as 15 degrees of the Equator passes through the Meridian, so oft you must examine what degrees of the Horizon the Vernal Colure cuts; and those degrees and minutes so cut by the Vernal Colure must be found in the Circle C B D E, beginning your account or reckoning at B towards D, and markt with Pricks: through which Pricks you must draw lines from the Center A, and those lines shall be the Hour lines after-noon. Then bring the Colure to the Meridian again to find the Fore-noon Hour-lines, and turn the Globe Eastwards, and so oft as 15 degrees of the Equator passes through the Meridian, so oft you must examine what degrees of the Horizon the Vernal Colure cuts; and those degrees and minutes so cut by the Vernal Colure must be found in the Circle C B D E, begining your reckoning from B towards C, and markt with Pricks: through which Pricks you must draw lines from the Center A, and those lines shall be the Fore-noon Hour-lines.

These Hour-lines must be markt from the Meridian line, *viz.* the line A B, which is the 12 a clock line towards D, with I, II, III &c. till you have numbred to the Hour of Sun set (found by Prob. 7. of the second Book) the longest Day, and from the Meridian line towards C with XI, X, IX, &c. till you have numbred to Sun Rising the longest Day.

The *Stile* must be placed in the Center and Elevated so many degrees above the Plane, as the Pole is elevated above the Horizon of the Place,

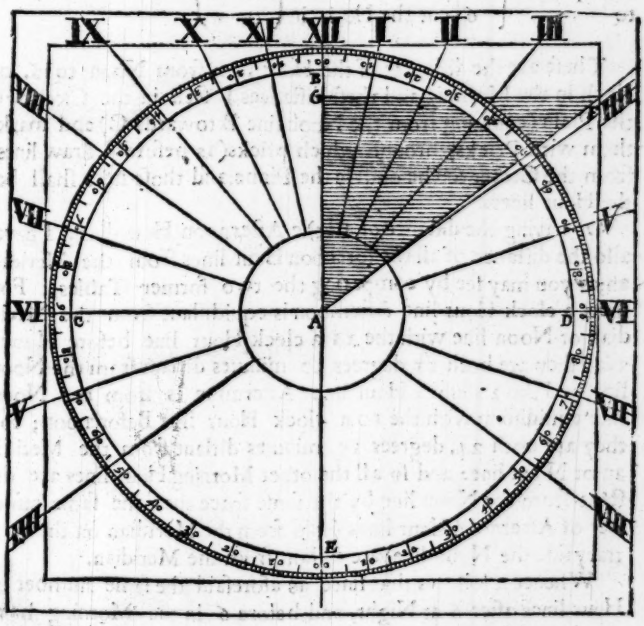
## Example of the whole.

I would make an Horizontal Dyal for *Londons* Latitude: Therefore I Elevate the North Pole 51 ½ degrees above the Horizon, and bring the Vernal Colure to the Meridian, and the Index of the Hour Circle to 12 on the Hour Circle;

| | | | | |
|---|---|---|---|---|
| And turning | 1 | a clock or till 15 | 11. 4 | |
| the Globe | 2 | deg of the Equa- | 24. 15 | |
| Westwards, | 3 | tor pass through | 38. 4 | from the Meridian. |
| till the In- | 4 | the Meridian; I | 53. 26 | |
| dex points | 5 | find the Colure | 71. 6 | |
| to | 6 | cut the Hori. in | 90. | |

These are the distances of the Hour lines from Noon till 6 at Night: and to these distances on the Plane (counting from B towards

wards D,) I make pricks; and from the Center I draw lines through theſe Pricks; and theſe lines are the Hour-lines from 12 to 6 Afternoon. But the Sun in the longeſt Day ſhines till paſt 8 at Night, as you may find by Prob. 48. of the ſecond Book, therefore here wants the two Evening Hour lines; which though they may be found after the ſame way I found the former, (*viz.* by continuing the turning of the Globe Weſtwards) yet that I may the ſooner reduce my work to the Plane, I Count the number of degrees between the 6 a clock line and the 5 a clock line in the Circle on the Plane; for the ſame number of degrees counted from D towards E is the diſtance of the 7 a clock Hour line from the 6 a clock Hour line; and the number of degrees contained between the 6 a clock Hour line and the 4 a clock Hour line is the diſtance of the 8 a clock Hour line from the 6 a clock Hour-line.




Or I need not draw the 7 and 8 a clock Hour lines, till I have drawn the forenoon Hour lines; for then by laying the edge of a Ruler

Ruler (that will reach through the oppoſite ſide of the Plane) to the Morning 7 and 8 a clock Hour lines, I may by the ſide of that Ruler draw lines from the Center through the oppoſite ſide of the Plane, and thoſe lines ſhall be the 7 and 8 a clock Hour lines Afternoon.

Having thus all the Afternoon Hour lines, I bring the Vernal Colure to the Meridian again; ſo ſhall the Index again point to 12. Therefore, as before I turned the Globe Weſtwards, ſo now

| | | | | |
|---|---|---|---|---|
| turning it Eaſtwards, till the Index points to | 11 | a clock, or till 15 deg. of the Equator paſs through the Meridian, I find the Colure cut the Hori. in | 11. 40 | from the Meridian. |
| | 10 | | 24. 15 | |
| | 9 | | 38. 4 | |
| | 8 | | 53. 36 | |
| | 7 | | 71. 6 | |
| | 6 | | 90. | |

Theſe are the diſtances of the Hour lines from Noon to 6. a clock in the Morning: and theſe diſtances I ſeek in the Circle of the Plain (counting from the Noon line B towards C) and mark them with Pricks; through which pricks (as before) I draw lines from the Center to the outſide the Plane: and thoſe lines ſhall be the Hour lines.

Or having the diſtance of all the Afternoon Hour-lines, I have alſo the diſtance of all the forenoon Hour lines from the Meridian; as you may ſee by comparing the two former Tables. For the 1 a clock Hour line Afternoon is equidiſtant from the Meridian or Noon line with the 11 a clock Hour line before Noon, *viz.* they are both 11 degrees 40 minutes diſtant from the Noon line, and the 2 a clock Hour line Afternoon is from the Noon line equidiſtant with the 10 a clock Hour line Beforenoon; for they are both 24. degrees 15. minutes diſtant from the Meridian or Noon line: and ſo all the other Morning Hour lines are diſtant from the Noon line by the ſame ſpace that the ſame number of Afternoon Hour lines (told from the Meridian on the contrary ſide the Noon line) are diſtant from the Meridian.

Whence it follows, that ſince (as aforeſaid) the ſame number of Hour lines after 6 at Night, and before 6 in the Morning have the ſame diſtance from the 6 a clock line that the ſame number of Hour lines before 6 at Night and after 6 in the Morning have from the 6 a clock line; and ſince the ſame number of Hour

lines

lines before Noon are equidiſtant from the Meridian or Noon line by the ſame ſpace of degrees that the ſame number of Hour lines Afternoon are; It follows(I ſay)that having found the diſtance of the ſix Hour lines either before or after Noon, you have alſo given the diſtance of all the other Hour lines.

If you will have the half Hour lines placed on your Dyal you muſt turn the Globe till the Index points to every half Hour in the Hour Circle,as well as to the whole,and examine the degrees of the Horizon cut by the Vernal Colure, as you did for the whole Hours;and in like manner transfer them to your Plane.

Having thus drawn all the Hour lines I count from the Noon line 51 $\frac{1}{2}$ degrees,the Elevation of the Pole here at *London*; and from the Center A I draw a ſtraight line,as A F through theſe 51 $\frac{1}{2}$ degrees,for the *Gnomon* or *Style*,and prolong it to the farthеſt extent of the Plane: From this *Gnomon* or *Style* I let fall a Perpendicular upon the Noon line,as F G: (this Perpendicular is called the Subſtile) and this Perpendicular and its Baſe (which is the Noon line) and *Hypothenuſa* (which is the *Gnomon*) ſhall make a Triangle, which being erected upon the Baſe, ſo as the Subſtile may ſtand Perpendicular to the Plane, the *Hypothenuſa* A F ſhall be the *Gnomon*,and be Parallel to the Axis of the World;and caſt a ſhadow upon the Hour of the Day.

## PROB. IIII.

### *To make an* Erect Direct South Dyal.

DRaw on your Plane an Horizontal line as C A D, as was ſhewed in the Preface: in the middle of this line(as at A) diſcribe as on a Center the Semi-Circle C B D: from the Center A let fall a Perpendicular,which ſhall divide the Semi-Circle into two Quadrants, each of which Quadrants you muſt divide into 90 degrees. Then Rectifie the Globe, Quadrant of Altitude,Colure and Hour Index: thus, Elevate the Pole of the Globe to the Latitude of your Place,and ſcrew the Quadrant of Altitude to the *Zenith*, Then bring the Vernal Colure to the Meridian,and the Index of the Hour Circle to the Hour of 12. in the Hour Circle; ſo ſhall your Globe,Quadrant of Altitude, Colure,and Hour Index be Rectified. And thus you muſt alwaies Rectifie them for the making of moſt ſorts of Dyals by the

Globe. Then to make an Erect Direct South Dyal, Bring the lower end of the Quadrant of Altitude to the West point of the Horizon; And turn the Globe Westwards till the Index points to all the Hours Afternoon; and examine in what numbers of degrees from the *Zenith* the Colure cuts the Quadrant of Altitude when the Index points to each Hour: for a line drawn from the Center A through the same number of degrees reckoned from the Perpendicular A B (which is the 12 a clock line) towards D on the Plane, shall be the same Hour lines the Index points at.

Thus in our Latitude, *viz.* 51 $\frac{1}{2}$ degrees, the Vernal Colure being brought to the Meridian and the Index to 12;

| | | | | |
|---|---|---|---|---|
| If you turn the Globe Westwards, till the Index points to | 1 | a clock, or till 15 deg. | 9. 18 | counted from the *Zenith*. |
| | 2 | of the Equator pass | 19. 15 | |
| | 3 | through the Meridian, the Colure will | 32. 5 | |
| | 4 | | 48. 0 | |
| | 5 | cut the Quadrant of | 67. 4 | |
| | 6 | Altitude in | 90. | |

And these are the distances of the Afternoon Hour lines; which you must transfer to the East side of your Plane, *viz.* from B towards D; and draw lines from the Center A through these distances; and these lines shall be your Afternoon Hour lines.

Note (once for all) when the Colure goes off that Circle you examine the Hour distances in, the Sun will shine no longer upon that Plane; As in this example the Colure goes off the Quadrant of Altitude at 6 a clock, therefore the Sun will not shine longer then till 6 a clock upon this Plane.

The Hour lines before Noon have the same distance from the Meridian that the Afternoon Hour lines have, as was shewed in the last Probleme: Only they must be drawn on the West side the Noon line, and counted from B towards C.

## Otherwise.

You may reduce all Verticals into Horizontals; if you Elevate the Pole of the Globe to the Complement of the Latitude of your Place, and bring the Vernal Colure to the Meridian under the Horizon, and the Index of the Hour Circle to 12; and turn the

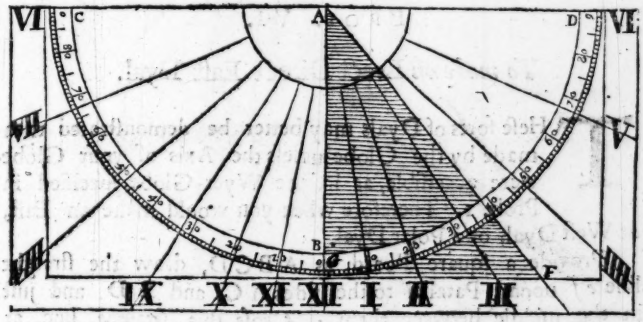
the Globe Weſtwards; for as the Index paſſes through every Hour on the Hour Circle, the Colure ſhews in the Horizon the diſtance of the ſeveral Afternoon Hour lines from the Meridian, or 12 a clock line, in the Circle on your Plane, numbred from B to D; and lines drawn from the Center through theſe diſtances on your Plane ſhall be the Afternoon Hour lines of your Dyal.

## Example.

*Londons* Latitude is 51 $\frac{1}{2}$ degrees, Its Complement to 90. is 38 $\frac{1}{2}$. Therefore I Elevate the Pole 38 $\frac{1}{2}$ degrees above the Horizon, and bring the Vernal Colure to the Meridian under the Horizon, and the Index of the Hour Circle to 12 on the Hour Circle. Then

| | | | | | |
|---|---|---|---|---|---|
| Turning the Globe Weſtwards, till the Index of the Hour Circle points to | 1 | a clock, or till 15 deg. of the Equator paſs through the Meridian, I find the Colure cut the Horizon in | 9 | 18 | from the Interſection of the Meridian and the Horizon: as in the former Table. |
| | 2 | | 19 | 15 | |
| | 3 | | 32 | 5 | |
| | 4 | | 48 | 0 | |
| | 5 | | 67 | 0 | |
| | 6 | | 90 | | |

And theſe are the diſtances of the 6 Hour lines from the Merid.




By this Example you may ſee that it is eaſie to reduce Verticals into Horizontals: and Horizontals into Verticals: for this Erect Direct South Dyal is an Horizontal Dyal to thoſe People that Inhabite 90 degrees from us, *viz.* in the South Latitude of 38 $\frac{1}{2}$ degrees.

Then make a Triangle, whereof the Noon line ſhall be

Baſe: from it count the Complement of the Poles Elevation, *viz.* 38 ½ degrees, and through them draw the line A F, from the Center A which ſhall be *Hypotenuſa*; Then let fall a Perpendicular upon the Noon line A B, ſo is your Triangle made. If this Triangle be erected Perpendicularly upon the Baſe or Noon line, The *Hypotenuſa* A F ſhall ſtand Parallel to the Axis of the World, and caſt a ſhadow upon the Hour of the Day.

## Prob. V.

### *To make an* Erect Direct North Dyal.

IF the Erect Direct South Dyal were turned towards the North; and the line C A D were turned downwards, and the line marked with 7 be now marked with 5, and the line 8 with 4, the line 5 with 7, and the line 4 with 8, then have you of it a North Erect Direct Dyal.

All the other Hour lines in this Dyal are uſeleſs, becauſe the Sun in our Latitude ſhines on a North Face the longeſt Day only before 6 in the Morning, and after 6 at Night.

## Prob. VI.

### *To make an* Erect Direct Eaſt Dyal.

THeſe ſorts of Dyals may better be demonſtrated then made by the Globe; unleſs the Axis of your Globe were acceſſible, as in the Wyer-Globe, ſpecified in Prob. 1. Therefore when you would make an Eaſt, or Weſt Dyal, or a Polar Dyal.

Provide a ſquare Board, as A B C D, draw the ſtraight line *e f* upon it Parallel to the ſides A C, and B D, and juſt in the middle between them: Croſs this ſtraight line at Right Angles with another ſtraight line, as *g h*, quite through the Board.

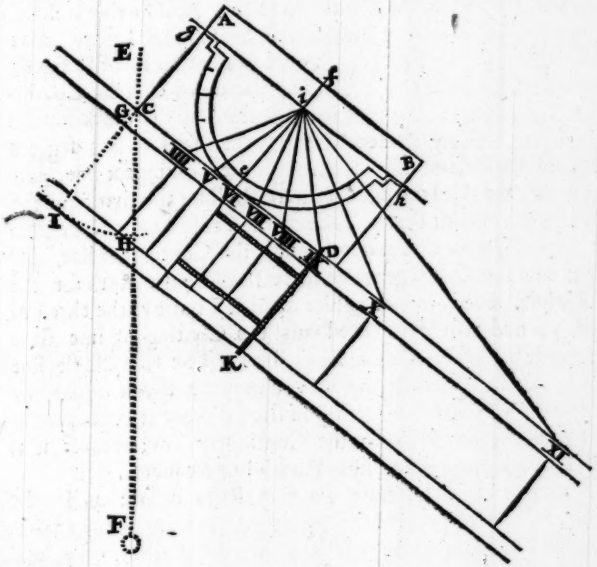
Upon this Board with a little Pitch or Wax faſten the Semi-Circle of Poſition, ſo as both the Poles thereof may ly in the line *g h*, and the middle of the Semi-Circle marked 90 may ly upon the line *e f*, ſo ſhall *i* be the Center of the Semi-circle of Poſition:

In

In this Center make a ſmal hole through the Board fit to receive a Wyer or a Nail. So may you with this Circle of Poſition thus fitted, and the ſide C D applyed to a line of Contingence elevated to the Height of the Equinoctial, draw lines from the Center through every 15 degrees of the Circle of Poſition, and by continuing them interſect the line of Contingence in the points from whence the Hour lines of an Eaſt or Weſt Dyal is to be drawn.

## Example.

I would make an Erect Direct Eaſt Dyal for *Londons* Latitude. Therefore I faſten a Plumb-line a little above the place




on the Wall where I intend to make my Dyal, and wait till it hangs quietly before the Wall: then if the line be rub'd with Chalk (like a Carpenters line) I may by holding the Plumbet end cloſe to the Wall, and ſtraining it pretty ſtif, ſtrike with it a

ſtraight line as *Carpenters* do. This line ſhall be a Perpendicular as E F: I chuſe a convenient point in this Perpendicular, as at G, for a Center; whereon I diſcribe an occult Arch as H I: this Arch muſt contain the number of degrees of the Elevation of the Equinoctial counted between H and I, (which in our Latitude is 38 ½.) Therefore in a Quadrant of the ſame Radius with the occult Arch I meaſure 38 ½ degrees, and ſet them off in the Plane from H in the Perpendicular to I: Then from I to the Center G in the Perpendicular, I draw the prickt line I G, and this line ſhall repreſent the Axis of the World: I croſs this Axis at Right Angles with the line G K and draw it from G. to K, ſo long as I poſſibly can: this line ſhall be the Contingent-line. I find a convenient place in this Contingent line as, at VI, to which I apply the ſide of the Board C *e* D, ſo as that the point *e* may ly juſt upon VI in the Contingent line; And having a thred faſtned in the Center of the Semi-Circle of Poſition, I draw that thred ſtraight over the firſt 15. degrees of the Circle of Poſition, numbred from o towards *b*, and where the thred cuts the Contingent line I make a mark, for that mark ſhall be the mark for the 7 a clock line. From thence I remove the thred to 30. degrees of the Semi-Circle, and draw it through the Contingent line, and where it cuts the Contingent line, there ſhall be the mark for the 8 a clock line. From thence I remove the thred to 45. degrees of the Semi-Circle and draw it through the Contingent line, and where it cuts the Contingent line there ſhall be the mark for the 9 a clock line. From thence in like manner I remove the thred to 60. and 75. and where the thred cuts the Contingent line ſhall be the mark for 10 and 11 a clock lines: The 12 a clock line cannot be drawn on this Plane, as you may ſee, if you apply the thred to 90 degrees, for though you ſhould draw it out never ſo far yet would it never touch the Contingent line: becauſe it is Parallel to the line *g h*, and lines Parallel never meet.

But becauſe in our Latitude the Sun Riſes before 4. in the Morning, therefore two Hour-lines are yet wanting, *viz.* 5, and 4, which I may find either by applying the thred firſt to 15, and next to 30 degrees from o towards *g* in the Semi-Circle, and ſo marking where it cuts the Contingent line, as before: Or elſe by transfering the diſtance of the ſame number of Hour lines from the 6 a clock line already drawn on the ſide *e h*, to the ſide *e g*, as in Prob. 2. of this Book is more fully ſhewed.

Having

Having thus marked out on the Contingent line the diſtances of each Hour; I draw a line Parallel to the Contingent line, and draw lines from every Hour markt on the Contingent to croſs the Contingent line at Right Angles, and continue each line to the line Parallel to the Contingent; and theſe lines ſhall be the Hour lines of an Eaſt Plane. To theſe Hour-lines I ſet Figures as in the Scheam may be ſeen.

The *Style* D K of this Dyal (as well as of others) muſt ſtand Parallel to the Axis of the World: it muſt be alſo Parallel to all the Hour lines, and ſtand directly over the 6 a clock line, and that ſo high as is the diſtance between the Center of the Semi-Circle of Poſition and the point where the 6 a clock line cuts the Contingent line: Or (which is all one) at ſuch a height as when it is laid flat down upon the Plane it may juſt reach the 3 a clock line.

## Prob. VII.

### *To make an* Erect Direct Weſt Dyal.

An Erect Direct Weſt Dyal is the ſame in all reſpects with an Erect Direct Eaſt Dyal; Only as the Eaſt ſhews the Fore-noon Hours, the Weſt ſhews the After-noon Hours.

Thus if you ſhould draw the Eaſt Dyal on any tranſparent Plane, as on Glaſs, Horn, or an Oyled Paper, on the one ſide will appear an Eaſt Dyal, and on the other a Weſt. Only the Figures as was ſaid before (muſt be changed); for that which in the Eaſt Dyal is 11, in the Weſt muſt be 1; that which in the Eaſt Dyal is 10, in the Weſt muſt be 2: that which in the Eaſt Dyal is 9 in the Weſt muſt be 3. &c.

## Prob. VIII.

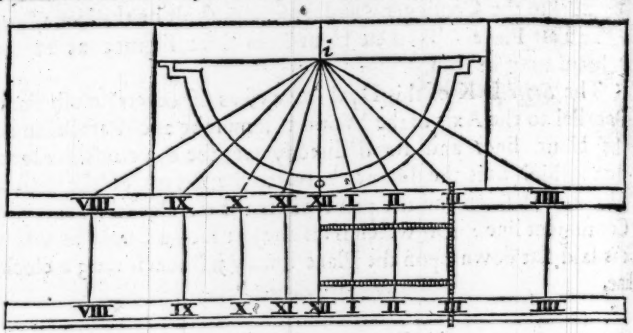
### *To make a* Polar Dyal.

Polar Dyals are Horizontal Dyals under the Equinoctial: They are of the ſame kind with Eaſt and Weſt Dyals; Only whereas Eaſt and Weſt Dyals have but the Hour lines of half the longeſt Day diſcribed on them, theſe have all the Hour lines

of

of the whole Day; and are marked on both sides the Noon line: as in the following Figure.

The *Style* of this Dyal must stand over the Noon line, Parallel to the Plane; for then it will also be Parallel to the Axis




of the World: and its height above the Plane must be the distance between the Center *i* of the Semi-Circle and the point in the Contingent line cut by the Noon-line. But I have inserted the Figure, which alone is sufficient Instructions.

## Prob. IX.

### *To make* Erect South Dyals, Declining *Eastwards, or Westwards.*

Draw on your Plane an Horizontal line, and on it discribe a Semi-Circle, as you were taught in Prob 4.

Then Rectifie the Globe, Quadrant of Altitude Colure, and Hour Index, as by the same Probleme: and bring the lower end of the Quadrant of Altitude to the degree of Declination from the East or West point, according as your Declination is Eastwards or Westwards; for then the Quadrant of Altitude shall represent a Plane declining from the South-Eastwards, or Westwards accordingly. Then turn the Globe Eastwards, till the Index of the Hour-Circle points to all the Hours before Noon, and examine in what number of degrees from the *Zenith* the Colure cuts the Quadrant of Altitude, when the Index points to each Hour, For a line drawn from the Center A through the same

ſame number of degrees reckoned from the Perpendicular A B, which is the 12 a clock line towards C on the Plane, ſhall be the ſame Hour-lines the Index points at.

## Example.

I would make an Erect Dyal declining from the South towards the Eaſt 27. degrees: The Globe, Quadrant of Altitude, Vernal Colure, and Hour Index Rectified, as before, I bring the lower end of the Quadrant of Altitude to 27. degrees counted from the Eaſt point of the Horizon towards the North: Then

| | | | | |
|---|---|---|---|---|
| I turn the Globe Eaſtwards till the Index points to | 11 | a clock, or till 15. deg. of the Equator paſs through the Meridian, and find the Colure cut the Quadrant of Altitude in | 9. 43 | counted from the *Zenith*. |
| | 10 | | 19. 0 | |
| | 9 | | 25.57 | |
| | 8 | | 35.10 | |
| | 7 | | 45.56 | |
| | 6 | | 60.15 | |
| | 5 | | 79.45 | |

And theſe are the diſtances of the Fore-noon Hour-lines, which I ſeek in the Weſt ſide of the Plane, *viz.* from B towards C; and through theſe diſtances I draw lines from the Center, and theſe lines ſhall be the Fore-noon Hour-lines.

Now herein is a difference between Declining Dyals, and Direct Dyals: For having found the diſtances of the Hour lines for one half of the Day, be it either for Before Noon or After Noon in a Direct Dyal, you have alſo found the diſtances for the other half Day; becauſe, as was ſaid Prob. 3. Equal number of Hours have equal diſtance from the Noon line: But in Declining Dyals it is not ſo: Becauſe the Sun remaining longer upon that ſide of the Plane which it declines to, then it doth upon the contrary ſide, there will be a greater number of Hour lines upon it, and by conſequence the diſtance of the Hour lines leſs then on the contrary ſide of the Plane.

Therefore for finding the After Noon Hour lines, I turn about the Quadrant of Altitude upon the *Zenith* point till the lower end of it come to the degree of the Horizon oppoſite to that degree of Declination that the Quadrant of Altitude was placed at when I ſought the Fore Noon Hour lines, *viz.* to 27. degrees

counted rom the West towards the South, and bring the Vernal Colure again to the Meridian, and the Index (as before) to 12. Then,

| | | | |
|---|---|---|---|
| turning the Globe Westwards till the Index points to | 1 a clock, or till | 15 degr. of the Equator pass through the Meridian, I find the Colure cut the Quadrant of Altitude in | 11. 20. 26. 47 49. 20 75. 52 |

counted from the *Zenith*.

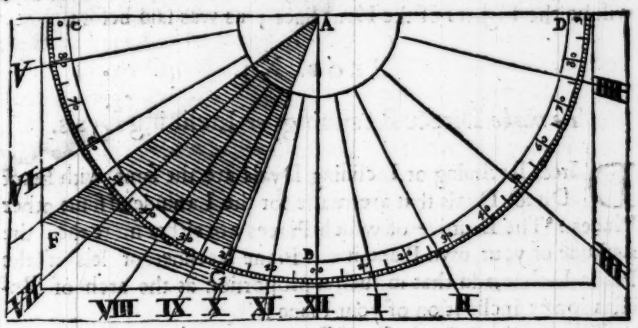
And these are the distances of the After Noon Hour lines, which distances I seek in the East side of the Plane, *viz.* from B towards D (as before) and so drawing lines from the Center A through these distances, I have all the Afternoon Hour lines also drawn on my Plane.

You may note, that this Plane is capable to receive no more Hour lines After Noon then 4. for when the Colure goes off the Quadrant of Altitude, the Sun goes off these kind of Planes.

To these Hour lines I set their numbers, as you may see in the Figure.

Then to find both the distances of the *Substilar line* from the 12 a clock line, and the Elevation of the *Style* above the Plane, Bring the Colure to the number of degrees of the Planes Declination, counted in the Horizon from the South point towards the East point, and the Quadrant of Altitude to the degrees of the Planes Declination, counted in the Horizon from the East point towards the North, so shall the Quadrant of Altitude and the Colure cut each other at Right Angles; and the number of degrees comprehended between the Colure and the *Zenith* in the Quadrant of Altitude, shall be the number of degrees between the *Substyler line* and the 12. a clock line, which in this Example is 19. degrees 45. minutes: And the number of degrees comprehended between the Quadrant of Altitude and the Pole, counted in the Colure, shall be the number of degrees that the *Style* is to be Elevated above the Plane; which in this Example is 33. degrees 40. minutes. Wherefore for the distance of the *Substyler line* from the 12 a clock line, I count in the Circle from the 12 a clock line in the contrary side of the Plane, *viz.* in the West side, because the Plane declines towards the East 19. degrees 45 minutes, as at D, and through that number of degrees and minutes from the Center A, I draw the line A G, which shall be the *Substylar line*: And from the *Substylar line* (either way) I number 33. degrees 40. minutes, the Elevation of the *Style* above the Plane, and through

through those degrees and minutes I draw from the Center A, the line A F, for the *Style* or *Gnomon*; Then I let fall the Perpendicular F G upon the *Substyle* A G: So is there a Triangle




made, which if it be erected Perpendicularly upon the *Substyle* A G, the *Style* A F shall be Parallel to the Axis of the World, and cast a shadow upon the Hour of the Day.

Here you may see that in Declining Dyals the *Style* doth not stand at the same Elevation above the Plane, that it doth in Erect Direct Dyals; neither doth it stand over the 12 a clock line; but swerves from it towards the Quarter of Declination.

## Prob. X.

### *To make a* North Erect Dyal *declining* Eastwards, *or* Westwards.

As in Prob. 5. an Erect Direct North Dyal hath the same Delineation that an Erect Direct South Dyal hath, and differs only in the placing the Figures of the Hour lines: So a North Erect Dyal that declines Eastwards, or Westwards, differs from a South Erect Dyal that Declines Eastwards, or Westwards, the same number of degrees, only in placing the Hour lines at the same distance on the contrary side of the Plane, and by transposing the Figures of 11 for 1: 10 for 2: 9 for 3. &c.

Thus, if you draw upon Glass, Horn, or an Oyled Paper, the South Dyal Declining Eastwards, as in the foregoing Probleme,

and place it to its due ſituation, the back ſide of it ſhall be a North Dyal declining towards the Weſt ſo many degrees as the foreſide Declines towards the Eaſt; and the only difference in it will be the Figures of the Hour lines; as was ſaid before.

## Prob. XI.

### *To make* Direct Reclining, *or* Inclining Dyals.

Direct Reclining or Inclining Dyals are the ſame with Erect Direct Dyals that are made for the Latitude of ſome other Places: The Latitude of which Places are either more then the Latitude of your own Place, if the Plane Recline, or leſs if the Plane Incline; and that in ſuch a proportion as the arch of Reclination or Inclination of your Plane is.

Thus a Direct South Dyal Reclining 10. degrees in *Londons* Latitude, *viz.* 51 $\frac{1}{2}$ degrees, is an Erect Direct Dyal made for the Latitude of 61 $\frac{1}{2}$ degrees: And a Direct South Dyal Inclining 10. degrees in the Latitude 51 $\frac{1}{2}$ degrees is an Erect Direct Dyal in the Latitude of 41 $\frac{1}{2}$ degrees: and is to be made according to the Directions in Prob. 4.

## Prob. XII

### *To make* Declining Reclining, *or* Declining Inclining Dyals.

The diſtances of the Hour lines either for a Declining Reclining Plane, or a Declining Inclining Plane may moſt eaſily be found upon the Plane of the Horizon, That is (as ſome Authors call it) by the Horizontal Dyal, by changing the Circles of the Globe one into another: So as the Plane of the Horizon may ſerve to repreſent the Dyal Plane; Yet this way not being natural, becauſe you muſt admit one Circle to be another, and that in Young Learners might ſometimes breed a little difficulty, *Gemma Friſius*, *Metius*, and *Blaew* hath preſcribed a thin Braſs plate to be made equal to a Semi-Circle of the Equinoctial, and divided from the middle point of it either way into 90 degrees, which may not unproperly be called a *Gnomonical Semi-Circle*. This Semi-Circle muſt be bowed cloſe

to

to the Body of the Globe into a Semi-Circular form, and ſo ſet to any Reclination, or Inclination, and then it will repreſent a Reclining or Inclining Plane: And by the motion of the Colure through the ſeveral degrees of this Semi-Circle the diſtances of the Hour lines may be found: Thus,

The Globe, Quadrant of Altitude, Colure, and Hour Index, Rectified; as by Prob. 4. Bring the lower end of the Quadrant of Altitude to the degree in the Horizon of the Planes Declination, if your Plane be a South Declining Recliner, and count on the Quadrant of Altitude from the *Zenith* downwards the number of degrees of Reclination, or Inclination, and to that number of degrees bring the middle of the *Gnomonical Semi-Circle*, and let the ends of it cut the Horizon on either ſide in the degrees of the Planes *Azimuth*, ſo ſhall the *Gnomonical Semi-Circle* repreſent a Reclining Plane. And ſo oft as 15. degrees of the Equator paſſes through the Meridian, ſo oft ſhall you enquire what degrees of the *Gnomonical Semi-Circle* the Colure cuts; for ſo many degrees aſunder muſt the ſeveral reſpective Hour lines of a Reclining Declining Plane be in a Semi-Circle divided into 180. degrees.

But if your Plane be a South Declining Recliner, or a North Declining Incliner; Bring the Quadrant of Altitude to the degree of the Horizon oppoſite to the degree of the Planes Declination, (becauſe the upper ſide of the Plane lies beyond the *Zenith*) counted from the South point in the South Recliners, and from the North point in North Incliners.

Then find the heigth of the *Style*, and place of the *Subſtyle*: thus, Keep your *Gnomonical Semi-Circle* in its poſition: But turn the Quadrant of Altitude about on the *Zenith* point till the lower end of it comes to the degree of the Horizon oppoſite to the degree it was placed at before, and turn about the Globe till the Colure cut the Quadrant of Altitude above the Horizon in the number of degrees the Plane Reclines from the *Zenith*; ſo ſhall the Colure cut the *Gnomonical Semi-Circle* at Right Angles; Then count the degrees contained between the middle of the *Gnomonical Semi-Circle* and the Colure, for that number of degrees is the diſtance of the *Subſtyle* from a Perpendicular line in the middle of your Plane, and muſt be placed Weſtwards of the ſaid Perpendicular, if your Plane decline from the South Eaſtwards; or Eaſtwards, if your Plane decline from the South Weſt-

wards. Then observe how many degrees are contained between the Semi-Circle and the Pole; for that number of degrees is the number of degrees that the *Style* is to be Elevated above the *Substyle*.

## Example.

Here at *London* I would make a Dyal upon a Plane Declining from the South Eastwards 30. degrees, and Reclining from the *Zenith* 20. degrees; *Londons* Latitude is 51 ½ degrees: Therefore, Having on the Plane discribed a Semi Circle, &c. as was directed Prob. 4. I Rectifie the Globe, Quadrant of Altitude, Colure, and Hour Index, as by the same Probleme, and bring the lower end of the Quadrant of Altitude to 30. degrees from the North point of the Horizon towards the West, because that is the degree opposite to the degree of the Planes Declination, *viz.* to 30 degrees from the South Eastwards, And I bring the middle of the *Gnomonical Semi Circle* to 20. degrees of the Quadrant of Altitude counted from the *Zenith* downwards towards the Horizon, and the ends of the *Gnomonical Semi Circle* to the degrees of *Azimuth* the Plane lies in in the Horizon, *viz.* to 30. degrees from the East point Northwards, and to 30. degrees from the West point Southwards, so shall 11. degrees 10. minutes of the *Gnomonical Semi Circle* be comprehended between the Quadrant of Altitude and the Brasen Meridian: These 11. degrees 10. minutes shews that the 12 a clock line is distant from the Perpendicular A B 11. degrees 10. minutes: and because the Plane Declines to the Eastwards, therefore the 12 a clock line must stand on the West side the Plane 11. degrees 10. minutes. Then to find all the Fore Noon Hour lines,

| | | | | |
|---|---|---|---|---|
| I turn the Globe Eastwards till the Index points to | 11 | a clock, or till | 15. 8 | counted from the middle of the *Gnomonical Semi Circle*. |
| | 10 | degr. of the Equator pass through the Meridian, and find the Colure cut the *Gnomonical Semi-Circle* in | 18. 56 | |
| | 9 | | 22. 37 | |
| | 8 | | 26. 52 | |
| | 7 | | 32. 37 | |
| | 6 | | 42. 5 | |
| | 5 | | 62. 43 | |

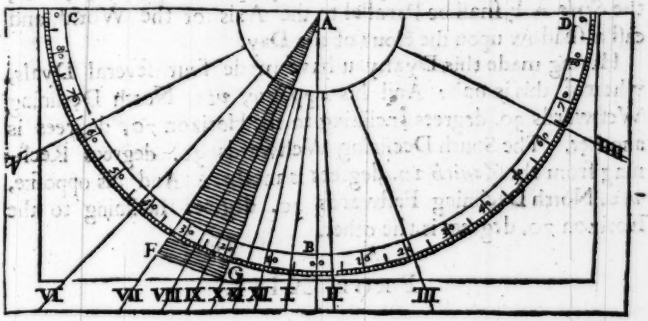
And these are the distances of the Fore Noon Hour lines; to which

which distances you may set Pricks on the West side the Semi Circle of the Plane, *viz.* from B to C.

The After Noon Hour lines are found by bringing the Colure again to the Meridian, and the Index of the Hour Circle to 12. for then

| | | | |
|---|---|---|---|
| turning the Globe Westwards till the Index points to | 1 / 2 / 3 / 4 | a clock, or till 15 degr. of the Equator pass throug the Meridian, I find the Colure cut the *Gnomon*, *Semi-Circle* in | 5. 45 / 2. 54 / 20.52 / 64.36 counted from the middle of the *Gnomon*, *Semi-Circle*. |

And these are the distances of the After-noon Hour-lines; and must all but the 1 a clock Hour-line be prickt down at their respective distances on the East side the Plane, *viz.* from B to D: But because the Colure comes not to the middle of the *Gnomonical Semi-Circle* before the first 15. degrees of the Equator pass through the Meridian after 12. therefore the 1 a clock must stand 5. degrees 45. minutes on the West side of the Plane: And for this cause I made distinction with a line between the 1 a clock




and the 2 a clock, in the foregoing Table. Then I draw lines from the Center A through every one of these pricks in the Semi-Circle, and they shall be the Hour lines of this Declining Reclining Plane.

Having drawn the Hour-lines, I remove the Quadrant of Altitude to the degree of the Horizon opposite to the degree it was at before, *viz.* to 30. degrees from the South Westwards, which is so much as the Plane declines Eastwards; But I let the *Gnomonical Semi Circle* stand as it did: And turning about the Globe

Globe till the Colure cut the Quadrant of Altitude in 20. degrees counted from the Horizon upwards, *viz.* the degrees of Reclination, I find 18. degrees 40. minutes contained between the middle of the *Gnomonical Semi Circle* and the *Brasen Meridian*, which is the distance of the *Substyle* from the Perpendicular; And I find the *Gnomonical Semi Circle* cut the Colure in 13. degrees 49. minutes from the Pole, which is the Height that the *Style* must be raised over the *Substyle*; Therefore I prick off in the Semi Circle on the Plane, the distance of the *Substyle* 18. degrees 40. minutes from the Perpendicular Westwards, because this Plane declines Eastwards: And from the Center A, I draw through that prick the line A E, which shall be the *Substyle*, and from this *Substyle* (either way) I count in the Semi Circle on the Plane 13. degrees 49. minutes, and there make a Prick: Then from the Center A, I draw through that Prick the line A F, to represent the *Style* or *Gnomon*: Then I let fall the Perpendiculer F G upon the *Substyle* A G; So is a Triangle made; which if it be erected Perpendicularly upon the *Substyle* A G, the *Style* A F shall be Parallel to the Axis of the World, and cast a shadow upon the Hour of the Day.

Having made this Dyal, you have made four several Dyals, whereof this is one: And his opposite, *viz.* North Declining Westwards 30. degrees Inclining to the Horizon 70. degrees is another. The South Declining Westwards 30. degrees Reclining from the *Zenith* 20. degrees is another: And his opposite, *viz.* North Declining Eastwards 30. degrees Inclining to the Horizon 70. degrees is the other.

## Prob. XIII.

### *To make a* Dyal *upon a* Declining Inclining Plane.

THe Precepts for making these Dyals are delivered in the foregoing Probleme: Therefore we shall at first come to an Example.

I would make a Dyal upon a Plane in *Londons* Latitude Declining from the South Westwards 25. degrees and Inclining towards the Horizon by the space of an Arch containing 14. degrees. Having first discribed on the Plane a Semi Circle, as was directed Prob. 4. I rectifie the Globe, Quadrant of Altitude,

Altitude, Colure, and Hour Index, as by the ſame Probleme, and bring the lower end of the Quadrant of Altitude to the degree of the Planes Declination, *viz.* to 25. degrees counted from the South Weſtwards, and the ends of the *Gnomonical Semi Circle* to the degree of *Azimuth* the Plane lies in, *viz.* to 25. degrees from the Weſt Northwards, and the middle of the *Gnomonical Semi Circle* to the degree of the Planes Inclination, *viz.* 14. degrees counted from the *Zenith* downwards on the Quadrant of Altitude, Then counting the degrees of the *Gnomonical Semi Circle* contained between the middle of the ſame and the *Braſen Meridian*, I find 5. degrees 30. minutes: Theſe 5. degrees 30. minutes ſhews the diſtance of the 12 a clock line from the Perpendicular; Therefore I number in the Semi Circle diſcribed on the Plane, from the Perpendicular Weſtwards, (Becauſe the middle of the *Gnomonical Semi Circle* lies Weſtwards on the Globe) from the Meridian, And for finding all the Fore-Noon Hour-diſtances

| | | | | |
|---|---|---|---|---|
| I turn the Globe Eaſtwards till the Index points to | 11 | a clock, or till 15 degr. of the Equa. paſs throug the Meridian, and find the Colure cut the *Gnomon*, *Semi-Circle* in | 20. 5 | counted from the middle of the *Gnomon*. *Semi-Circle*. |
| | 10 | | 36. 57 | |
| | 9 | | 56. 24 | |
| | 8 | | 76. 31 | |

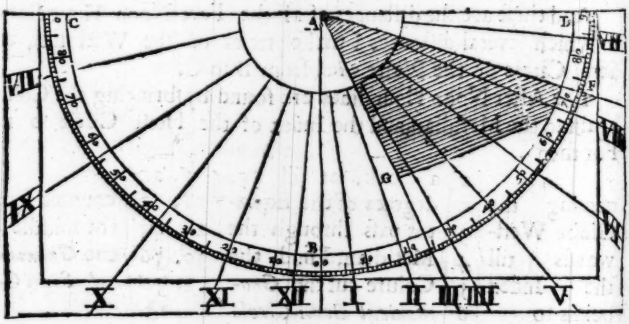
And theſe are the diſtances of all the Fore Noon Hour lines; to which ſeveral diſtances I make pricks on the Weſt ſide the Semi Circle on the Plane, *viz.* from B to C.

The After Noon Hour lines are found by bringing the Colure again to the Meridian, and the Index of the Hour Circle to 12. For then

| | | | | |
|---|---|---|---|---|
| turning the Globe Weſtwards till the Index points to | 1 | a clock, or till 15. degrees of the Equator paſs through the Meridian, I find the Colure cut the *Gnomonical Semi-Circle* in | 6. 20 | counted from the middle of the *Gnomonical Semi Circle*. |
| | 2 | | 18. 2 | |
| | 3 | | 28. 45 | |
| | 4 | | 39. 56 | |
| | 5 | | 52. 30 | |
| | 6 | | 67. 19 | |
| | 7 | | 84. 13 | |

And theſe are the diſtances of the After Noon Hour lines, which I alſo prick down at their reſpective diſtances from the Perpendicular Eaſtwards, *viz.* from B towards D on the Plane; and by drawing lines from the Center A through all the Pricks, I have all the Hour lines that this Plane will admit of.

Having drawn the Hour lines, I remove the lower end of the Quadrant of Altitude to the degree of the Horizon oppoſite to the degree it was at before, *viz.* to 25. degrees from the North Eaſtwards, which is ſo much as the Declination is Weſtwards; but I let the *Gnomonical Semi Circle* ſtand as it did, and turn about the Globe till the Colure cut the Quadrant of Altitude in 14. degrees counted from the Horizon upwards, which is the Inclination of the Plane: Then I find 24. degrees 3. minutes comprehended between the middle of the *Gnomonical Semi Circle* and the *Braſen Meridian*, which is the diſtance of the *Subſtyle* from the Perpendicular: and this diſtance I count Weſtwards on the Plane, becauſe the middle of the Semi Circle lies Weſtwards on the Globe and draw the line A G through it for the *Subſtyle*: And I find the *Gnomonical Semi Circle* cut the Colure in 48. degrees 5. minutes, for the Heigth that the *Style* muſt be Elevated over the *Subſtyle*: Therefore I make a prick on the Plane 48. degrees 5 minutes diſtant from the *Subſtyle*, and through that prick I draw the line A F to repreſent the *Style* or *Gnomon*; Then I let fall the Perpendicular F G upon the *Subſtyle* A G, ſo is there a Triangle made, which if it be erected




Perpendicularly upon the *Subſtyle* A G, the *Style* A F ſhall be Parallel to the Axis of the World, and caſt a ſhadow upon the Hour of the Day.

Having made this Dyal you have alſo four Dyals made; as well as in the former Probleme: For this is one, and its oppoſite *viz.* North declining Eaſtwards 25. degrees Reclining 76. degrees is another; The South declining Eaſtwards 25. degrees Incli-

Inclining 14. degrees is another; and its oppoſite, *viz.* North declining Weſtwards 25. degrees Reclining 76. degrees is another.

## PROB. XIV.

*To find in what Place of the* Earth *any manner of Plane that in your* Habitation *is not* Horizontal, *ſhall be* Horizontal.

IT was ſaid in the *Preface* that all manner of Planes however ſcituate are Parallel to ſome Country or other on the Earth: Therefore all manner of Planes are indeed Horizontal Planes: and the diſtances of the Hour lines to be deſcribed on them may be found as the diſtances of the Hour lines of the Horizontal Dyal in Prob. 3. It reſts now to learn in what place of the Earth any Plane that is not Horizontal in your Habitation ſhall become Horizontal: And for help of your underſtanding herein, Take theſe following Rules.

1. If your Plane be Erect Direct North, or South, it ſhall be an Horizontal in the ſame Longitude at 90. degrees diſtance on the Meridian, (counted from the *Zenith* of your Place,) through the Equinoctial. See an Example of this in Prob. 3. where I have reduced an Erect Dyrect Dyal, to an Horizontal. Thus an Erect Plane under the Pole is an Horizontal under the Equator; and an Erect Direct in 80. degrees North Latitude is in the ſame Longitude an Horizontal at 10. degrees South Latitude: An Erect Direct in 70. degrees North Latitude, is in the ſame Longitude, an Horizontal at 20. degrees South Latitude: and ſo to any other degrees of Latitude (as aforeſaid) till you come to 45. degrees Latitude, where an Erect is an Horizontal, and an Horizontal an Erect: Only as the Hour lines of the Horizontal (being turned downwards) are numbred from the right hand towards the left, in the Erect Direct Dyal they are numbred from the left hand towards the Right.

2. If your Plane be Erect Declining, it ſhall be an Horizontal Plane at that point on the Globe which is againſt the degree of Declination found in the Horizon.

But note, If your Plane declines Weſtwards, the Sun comes ſooner to the Meridian of it, then to the Meridian of the Place

where it becomes an Horizontal Plane; and that by so many Hours or minutes as the degrees of the difference of Longitude between the two Places converted into Time amounts to. If it declines Eastwards, the Sun comes so much later to the Meridian of it: And for this Cause (though the making this Dyal be the same with an Horizontal Dyal for another Place, yet in Respect of Time) there will be a difference between them.

## Example.

I would make the South Dyal Declining East 27. degrees, as in Prob. 9. by the Plane of the Horizon: First I seek in what Place of the Earth it shall become an Horizontal Plane: Thus, I Elevate the Pole of the Globe 51 $\frac{1}{2}$ degrees above the Horizon, and bring the Vernal Colure to the Meridian, then I count from the South point in the Horizon Eastwards 27. degrees, and on the point on the Globe directly against those 27. degrees I make a prick for the Place where a Plane that declines 27. degrees from the South Eastwards at *London* shall be Horizontal; or which is all one, this Declining Plane at *London* shall ly in the Horizon of that Prick: This Prick for distinction sake we shall hereafter call the Horizontal Place: Then by Prob. 1. of the Second Book, I examine the Latitude and Longitude of this Horizontal Place, and find Latitude 33. 40. South; and Longitude from the Colure 33. degrees, which is the difference of Longitude between *London* and the Horizontal Place: which being converted into Time by allowing for every 15. degrees 1. hour of Time, gives 2 hours 12 minutes that the Sun comes sooner to the Meridian of the Horizontal Place, then to the Meridian of the Plane at *London*: so that when it is 12 a clock there, it will be but 9. a clock 48. minutes here; when 12 a clock here, it will be 2 a clock 12 minutes There, &c.

Having thus found in what Longitude from *London* and Latitude this Plane is Parallel to the Horizon, I seek the distances of the Hour-lines upon the Planes of the Horizon Thus, I Elevate the Pole of the Globe to the Height of the Pole in the Horizontal Place, *viz.* 33. degrees 40. minutes, and bring the Horizontal Place on the Globe to the Meridian, and the Index of the Hour Circle to 12. Then I examine the degree of the Horizon the Colure cuts, and find it 19 $\frac{3}{4}$ from the South Westwards. This 19 $\frac{3}{4}$ degrees

degrees represents the Meridian line of the Horizontal Place: And also the *Substylar line* here at *London*; Therefore this 19$\frac{3}{4}$ degrees I count from the Perpendicular A B of the Plane, and from the Center A draw the line A G through them; Because from this line on the Plane all the Hour lines must be numbred, and not (as all along hitherto) from the Perpendicular of the Plane. Then

| turning the Globe Eastwards till the Index of the Hour Circle points to | a clock, or till | degr. of the Equator pass through the Meridian, I find the Colure cut the Horizon in | from the Meridian. |
|---|---|---|---|
| 11 | | 10. 2 | |
| 10 | | 0. 45 | |
| 9 | | 6. 12 | |
| 8 | | 15. 25 | |
| 7 | | 26. 11 | |
| 6 | | 40. 30 | |
| 5 | | 60. 0 | |

And these are the distances of the Forenoon Hour lines: which distances I transfer by pricks to the Plane. But as in Prob. 9. I sought the distances from the Perpendicular on the Plane, so now in this Case (as was said before) I seek them from the *Substyle*, and through these pricks I draw lines from the Center, as in other Dyals, and these lines shall be the Fore Noon Hour lines.

To find the Afternoon Hour distances, I bring the Horizontal Place on the Globe again to the Meridian, and the Index of the Hour Circle to 12. and

| turning the Globe Westwards till the Index points to | a clock, or till | degr. of the Equator pass through the Meridian, I find the Colure cut the Horizon in | counted from the Meridian. |
|---|---|---|---|
| 1 | | 31. 5 | |
| 2 | | 46. 32 | |
| 3 | | 68. 5 | |
| 4 | | 95. 37 | |

And these are the distances of all the Afternoon Hour lines; which I also transfer to the Plane, counting them from the *Substyle*, and draw lines from the Center A through these distances; and these lines shall be all the Afternoon Hour lines.

Then from the *Substyle* I count the degrees and minutes of the Latitude of the Horizontal Place, *viz.* 33. degrees 40. minutes, and through these degrees and minutes I draw the line A F from the Center A, for the *Style*: Then from the *Style* I let fall the Perpendicular F G upon the *Substyle*, so is there a Triangle made; which if it be erected Perpendicularly upon the *Substyle* A G, the *Style* A F shall be Parallel to the Axis of the World, and cast a shadow upon the Hour of the Day.

3. If your Plane be a Direct Recliner, Seek in the Longitude of your Place the Complement to 90. of your Planes Reclination: For there a Direct Recliner becomes an Horizontal Plane.

4. If your Plane be a Declining Recliner: The Globe and Quadrant of Altitude Rectified, Bring your Habitation on the *Terrestrial* Globe to the Meridian, and the Quadrant of Altitude to the Declination, as by the second Rule in this Probleme; and count upwards on the Quadrant of Altitude the Reclination, and there make a prick on the Globe by the side of the Quadrant of Altitude, for at that prick on the Globe the Declining Recliner shall become an Horizontal Plane. Then examine the Latitude of that prick as by Prob. 1. of the second Book, and the difference of Longitude, as by Prob. 9. of the third Book: And convert the difference of Longitude into Time, by allowing for every 15. degrees 1. hours Time, for every degree 4. minutes Time, and so proportionably, so shall you know what Hours and Minutes the Sun comes sooner or later to the Meridian of your Habitation then to the Meridian of that Place where it becomes an Horizontal Plane: Sooner, if the Globe were turned Eastwards; but Later if it were turned Westwards.

Having thus found out where this Plane becomes Horizontal, make your Dyal to this Plane, as by the second Rule in this Probleme. Find also the *Style* as is there directed.

5. If your Plane be a Declining Incliner, The Globe and Quadrant of Altitude Rectified, Bring the Colure to the Meridian, and the Quadrant of Altitude to the degree of the Horizon opposite to the degree of the Planes Declination, and count upwards on the Quadrant of Altitude the degrees of Inclination, and make a prick there; For in the *Antipodes* of that prick (found as by Prob 29. of the second Book) that Declining Incliner shall become an Horizontal Plane. Then find the Latitude and difference of Longitude of this *Antipodes*, by the former Rule, and make a Dyal to that Plane, as by the second Rule in this Probleme. Find also the *Style* as therein is directed.

PROB.

## Prob. XV.

*To make a* Dyal *on the* Ceeling *of a* Room, *where the* Direct Beams *of the* Sun *never come.*

FInd ſome convenient place in the Tranſum of a Window to place a ſmal round peece of Looking-Glaſs, about the bigneſs of a Groat, or leſs; ſo as it may ly exactly Horizontal: The point in the middle of this Glaſs we will marke A, and for diſtinctions ſake (with Mr *Palmer*) call it *Nodus:* Through this *Nodus* you muſt draw a Meridian line on the Floor, Thus: Hang a Plumb line in the Window exactly over *Nodus*, and the ſhadow that that Plumb line caſts on the Floor juſt at Noon will be a Meridian line; Or you may find a Meridian line otherwiſe, as by the *Preface*. Having drawn the Meridian line on the Floor, find a Meridian line on the Ceeling, thus: Hold a Plumb line to the Ceeling, over that end of the Meridian line next the Window; If the Plumbet hang not exactly on the Meridian line on the Floor, remove your hand on the Ceeling one way or other, as you ſee cauſe till it do hang quietly juſt over it: and at the point where the Plumb-line touches the Ceeling make a mark, as at B; that mark B ſhall be directly over the Meridian line on the Floor; then remove your Plumb line to the other end of the Meridian line on the Floor, and find a point on the Ceeling directly over it as you did the former point, as at C, and through thoſe two points B and C on the Ceeling ſtrain and ſtrike a line blackt with Smal Cole or any other Culler (as *Carpenters* do,) and that line B C on the Ceeling ſhall be a Meridian line, as well as that on the Floor: Then examine the Altitude of the Equinoctial, as by Prob. 6. of the Second Book you did the Meridian Altitude of the Sun; and faſten a ſtring juſt on the *Nodus*, and remove that ſtring in the Meridian line on the Ceeling till it have the ſame Elevation in a Quadrant, that the Equinoctial hath in your Habitation; and through the point where the ſtring touches the Meridian line in the Ceeling ſhall a line be drawn at right Angles with the Meridian, to repreſent the Equinoctial line. Thus, in our Latitude the Elevation of the Equator being 38 ½ degrees; I remove the ſtring faſtned to the *Nodus* forwards or backwards in the Meridian line of the Ceeling, till the Plumb line of a

Quadrant

Quadrant, when one of the sides are applyed to the string, falls upon 38 ½ degrees: and then I find it touch the Meridian line at D in the Ceeling: therefore at D I make a mark and through this mark strike the line D E (as before I did the Meridian line) to cut the Meridian line at Right Angles: This line shall be the Equinoctial line.

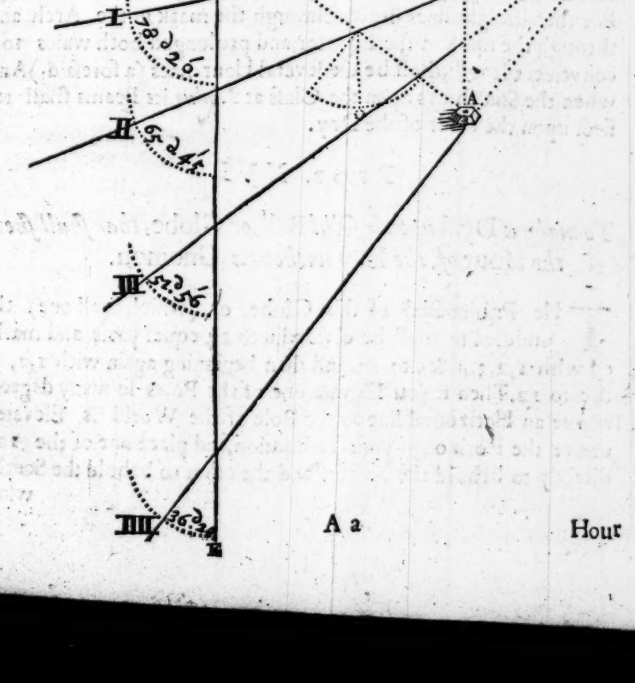
Then I place the Center of the Semi-Circle of Position upon *Nodus*, and under-prop it so that the flat side of it may ly Parallel to the string when it is strained between the *Nodus* and the Equinoctial, and also so as the string may ly on the division of the Semi-Circle marked o, when it is held up to the Meridian line in the Ceeling: Then removing the string the space of 15. degrees in the Circle of Position to the Eastwards, and extending it to the Equator on the Ceeling, where the string touches the Equator there shall be a point through which the 1 a clock Hour-line shall be drawn: and Removing the string yet 15. degrees further to the Eastwards in the Semi-Circle of Position, and extending it also to the Equator, where it touches the Equator there shall be a point through which the 2 a clock Hour-line shall be drawn: Removing the string yet 15. degrees further to the Eastwards in the Semi-Circle of Position, and extending it to the Equator, there shall be a point through which the 3 a clock Hour-line shall be drawn: The like for all the other After-Noon Hour lines; so oft as the string is removed through 15. degrees on the Semi-Circle of Position, so oft shall it point out the After-Noon distances in the Meridian line on the Ceeling.

The scituation of the Semi-Circle of Position cannot conveniently be shewn in this Figure, unless it be drawn by the Rules of Perspective; Neither if it were would it suit with the other demonstrations, except they were drawn by the same Rules also; which to do would be hard for young Learners to understand: Therefore I have left out the Semi-Circle of Position in this Figure and refer you for a demonstration thereof to the sixth Probleme; For even as the lines drawn through every 15. degrees of the Semi-Circle there, denote in a Contingent line the distance of any Hour line from the Meridian line, even so a line drawn through every 15. degrees of the Semi-Circle of Position posited (as aforesaid) point out in the Equinoctial line on the Ceeling the distance of each respective Hour line from the Meridian line,

Having

Having thus found out the points in the Equator through which the After-Noon Hour-lines are to be drawn, I may find the Fore-Noon Hour distances also the same way, *viz.* by bringing the string to the several 15. degrees on the West side the Semi-Circle of Position; or else I need only measure the distances of each Hour distance found in the Equator from the Meridian line on the Ceeling; for the same number of Hours from 12 have the same distance in the Equinoctial line on the other side the Meridian both Before and Afternoon: The 11 a clock Hour distance is the same from the Meridian line with the 1 a clock distance on the other side the Meridian, the 10 a clock distance the same with the 2 a clock distance, the 9 with the 3, &c. And thus the distances of all the Hour lines are found out on the Equator.

Now if the Center of this Dyal lay within doores, you might draw lines from the Center through these pricks in the Equator, and those lines should be the Hour lines, as in other Dyals: But the Center of this Dyal lies without doores in the *Air*, and therefore not convenient for this purpose: So that for drawing the



Hour lines you must consider what angle every Hour line in an Horizontal Dyal makes with the Meridian; that is, at what distance in degrees and minutes the Hour lines of an Horizontal Dyal cut the Meridian; which you may examine as by Prob. 3. for an Angle equal to the Complement of the same Angle must each respective Hour-line make with the Equator on the Ceeling.

Thus upon the point markt for each Hour distance in the Equinoctial line on the Ceeling, I discribe the Arches I, II, III, IIII, as in the Figure, and finding the distance from the Meridian of the Hour-lines of an Horizontal Dyal to be according to the third Probleme. Thus

The $\begin{Bmatrix}1\\2\\3\\4\end{Bmatrix}$ a clock Hour-line $\begin{Bmatrix}11.40\\24.15\\38.\ 4\\53.36\end{Bmatrix}$ whose Complement to 90. is $\begin{Bmatrix}78.20\\65.45\\51.56\\36.24\end{Bmatrix}$

I measure in a Quadrant of the same Radius with those arches already drawn from the Equinoctial line

for the $\begin{Bmatrix}1\\2\\3\\4\end{Bmatrix}$ a clock Hour $\begin{Bmatrix}78.20\\65.45\\51.56\\36.24\end{Bmatrix}$

and transfer these distances to the Arches drawn on the Ceeling: For then straight lines drawn through the mark in the Arch, and through the mark in the Equator, and prolonged both waies to a convenient length, shall be the several Hour-lines (a foresaid;) And when the Sun shines upon the Glass at *Nodus*, its Beams shall reflect upon the Hour of the Day.

## Prob. XVI.

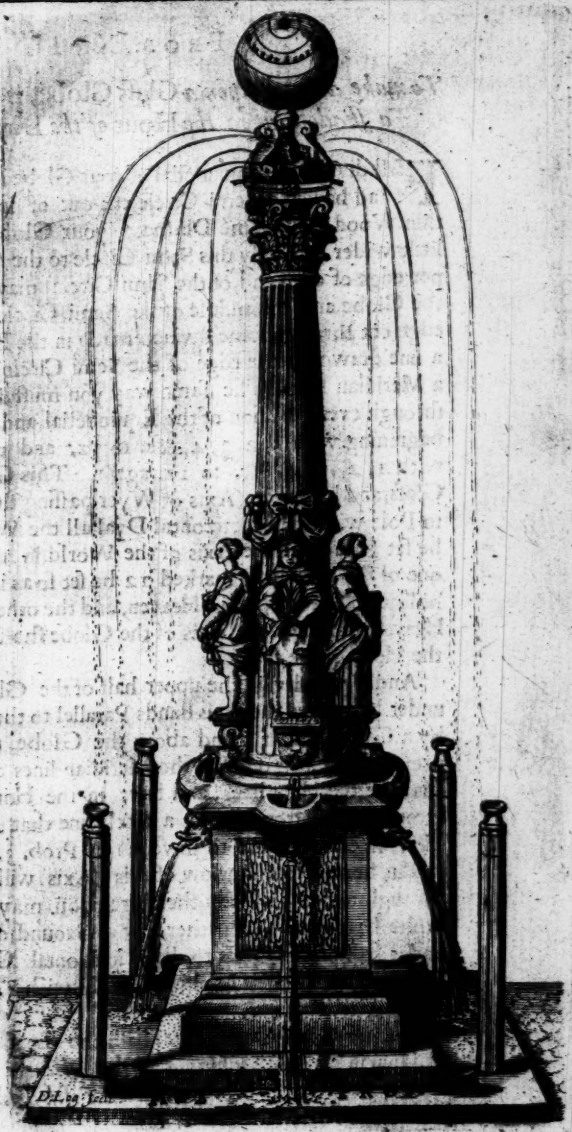
### *To make a* Dyal *upon a solid* Ball, *or* Globe, *that shall shew the* Hour *of the* Day *without a* Gnomon.

The Equinoctial of this Globe, or (which is all one) the middle line must be divided into 24 equal parts, and marked with 1,2,3,4 &c. to 12. and then beginning again with 1,2, 3, &c. to 12. Then if you Elevate one of the Poles so many degrees above an Horizontal line as the Pole of the World is Elevated above the Horizon in your Habitation, and place one of the 12s directly to behold the North, and the other to behold the South:

when

when the Sun ſhines on it the Globe will be divided into two halfs, the one enlightened with the Sun-ſhine, and the other ſhadowed: and where the enlightened half is parted from the ſhadowed half, there you ſhall find in the Equinoctial the Hour of the Day; and that on two places on the Ball; becauſe the Equinoctial is cut in two oppoſite points by the light of the Sun.

A Dyal of this ſort was made by Mr *John Lenk*, and ſet up on a Compoſite Columne at *Leaden Hall* Corner in *London*, in the *Majoralty* of Sr *John Derkick* Knight. The Figure whereof I have inſerted, becauſe it is a pretty peece of Ingenuity, and may perhaps ſtand ſome Lover of Art in ſtead, either for Imitation, or help of Invention.



## Prob. XVII.

*To make a* Dyal *upon a* Glass Globe, *whose* Axis *shall cast a shadow upon the* Hour *of the* Day.

FIrst divide the Equinoctial of your Globe into 24 equal parts; and having a Semi-Circle cut out of some Brass plate, or thin Wood to the same Diameter your Globe is of, or a very little wider: Apply this Semi-Circle to the Globe, so as the upper edge of each end of the Semi Circle may touch the Poles of the Globe, and the middle of the Semi Circle may at the same edge cut through some division made in the Equinoctial; for then a line drawn by the edge of the Semi Circle thus posited shall be a Meridian line; The same way you must draw Meridian lines through every division of the Equinoctial, and set figures to them, beginning with 1, 2, 3, 4, &c. to 12. and then beginning again with 1, 2, 3, 4, &c. to 12. again. This Globe being made of Glass, and having an Axis of Wyer passing through it from Pole to Pole, will be an Horizontal Dyal all the World over; if its Axis be set Parallel to the Axis of the World in the same Place; and one of the Meridians marked 12 be set so as it may directly behold the North point in Heaven, and the other the South point in Heaven; for then the Axis of the Globe shall cast a shadow upon the Hour of the Day.

And if you divide the upper half of the Glass Globe from the under half, when the Axis stands Parallel to the Axis of the World, by a Circle drawn round about the Globe, that Circle shall represent the Horizon; and the Meridian lines drawn on the Globe shall be the Hour lines, and have in the Horizontal Circle the same distance from the 12 a clock line that the same respective Hour line was found to have, as by Prob. 3. of this Book.

But because the shadow of this Axis will not be discerned through the Glass Body; therefore you may with Water and white Lead ground together, lay a Ground on the Inside of the under half of the Glass to the Horizontal Circle (as Looking-glass makers do their Looking Glasses with *Tinsoil*) for then the shadow will appear.

Such a Glass Globe Dyal hath the Lord *Robert Titchborn* standing in his *Garden* supported by *Atlas*.

*The End of the Fifth Book.*

# The Sixth BOOK.

*Shewing the Practical Use of the*

# GLOBES:

*Applying them to the Solution of*

# Spherical Triangles.

## PRÆFACE.

THe *Solution of* Spherical Triangles *is to know the length of its Sides, and the width of its Angles. These have already by many learned Men been taught, to be performed by a* Canon *of* Sines *and* Tangents; *and also by many Instruments some serving as Tables of* Sines *and* Tangents, *such as are the* Sectors, Scales, *the* Spiral line, *&c. and others serving to represent the* Globe; *such as be the* Mathematical Jewel, Astrolabium Catholicum, *and several other Projections of the* Sphear. *But none hath as yet taught the Solution of* Spherical Triangles *by the* Globe *it self; though it be the most natural, and most demonstrative way of all, and indeed ought first to be learnt before the Learner enters upon any other way.*

To

*To this Authors of* Trigonometry *agree, for the moſt of them in their Books give Caution that the Learner be already ſufficiently grounded in the Principles of the* Globe: *For thoſe* Lines *or* Circles *which either in Tables or other Inſtruments your force your Imagination to conceive repreſents your* Line *or* Circle *in queſtion, thoſe* Lines *and* Circles *I ſay, you have Actually and Naturally diſcribed on the* Globe, *and therefore may at a ſingle Operation, or perhaps only by a ſudden inſpection, have an Anſwer annexed, according as the nature of your Queſtion ſhall require: and that more Copiouſly then by* Tables *of* Sines *and* Tangents: *For therein you find but one Queſtion at once reſolved: but by the* Globe *you have alwaies two reſolved together.*

## *Of the Parts and Kindes of* Spherical Triangles.

### *THEOREMS.*

1. ALL Spherical Triangles are made of ſix parts; Three Sides, and three Angles. The Sides are joyned together at the Angles, and meaſured by degrees of a Great Circle, from one end to the other. The Angles are the diſtance of the two joyned ſides: and they are alſo meaſured by an Arch of a Circle, diſcribed on the Angular point. If any three of theſe parts be known, the reſt may be found.

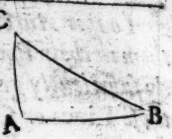
2. All Spherical Triangles are either Right Angled, or Oblique Angled. A Right Angle contains 90. degrees: An Oblique Angle either more, or leſs.

3. If a Spherical Triangle have one or more Right Angles; it is called a Right Angled Spherical Triangle. But if it have no Right Angle; it is called an Oblique Angled Spherical Triangle.

4. If an Oblique Spherical Triangle have one Angle greater then a Right Angle: it is called an Obtuſe Angled Spherical Triangle: But if it have no Angle greater, it is called an Accute Angled Spherical Triangle.

5. In Right Angled Triangles the ſides including the Right Angle are called Legs: And the ſide oppoſite to the Right Angle

gle is called Hypothenuſa. Thus the ſides A B and A C in the following Triangle are called Legs; and the ſide B C is called Hypothenuſa.




6. In a Right Angled Spherical Triangle one of the Legs are called Baſe; the other Perpendicular: Thus the Leg B A is Baſe; and the Leg C A Perpendicular. But the Terms may be varied: for the Baſe may be made Perpendicular, and the Perpendicular Baſe. Alſo One of the adjacent Angles is called the Angle at the Baſe; the other the Angle at the Perpendicular: Thus the Angle B is called the Angle at the Baſe: the Angle C the Angle at the Perpendicular.

## Prob. I.

### *The* Legs *of a* Right Angled Spherical Triangle *given: to find the* Hypothenuſa, *and the two other* Angles.

Note. THe Baſe of a Right Angled Spherical Triangle ſhall in this following Treatiſe be alwayes placed on a Meridian, the Perpendicular on the Equator, the Hypothenuſa on the Quadrant of Altitude, and the Angle at the Baſe ſhall be meaſured in an Arch of the Horizon.

Elevate the Equinoctial into the *Zenith*, ſo ſhall the Poles of the Globe ly in the North and South points of the Horizon.

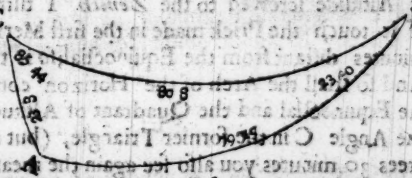
Then count from the Equinoctial on the firſt Meridian, if you uſe the *Terreſtrial Globe*; or on the Vernal Colure, if you uſe the *Celeſtial*, becauſe they are divided from the Equinoctial either way into 90. degrees; and becauſe from thence the degrees of the Equinoctial are begun to be numbred: Count (I ſay) from the Equinoctial the number of degrees the Baſe contains, and there make a prick: Then count in the Equinoctial from the firſt Meridian the number of degrees the Perpendicular contains, and make there a ſecond Prick: Bring that ſecond Prick to the Braſen Meridian, ſo ſhall the firſt Meridian be ſeparated from the Braſen Meridian by the quantity of an Arch equal to the meaſure of the Perpendicular: Then having the Quadrant of Altitude ſcrewed in the *Zenith*, turn it about till the ſide of it cut the Prick made in the firſt Meridian; ſo ſhall the Triangle

Triangle be represented on the Globe. The Base shall ly on the first Meridian between the Equinoctial and the Quadrant of Altitude, the Perpendicular in the Equinoctial between the first Meridian and the Brasen Meridian; and the Hypothenusa on the Quadrant of Altitude between the *Zenith* and the first Meridian; and the number of degrees between each of these respective Arches shall be the measure of each respective Side. For the Angles; The Right angle is known to be 90. degrees, by the second Theorem in the Preface. The measure of the Angle at the Perpendicular is numbred between the East point in the Horizon, and the graduated edge of the Quadrant of Altitude: But to find the Angle at the Base you must turn the Triangle, makeing the Perpendicular Base, and the Base Perpendicular.

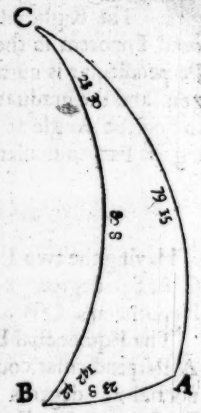
## Example.

Having the two Legs given A B 79. degreee 15. minutes, and C A 23. degrees 8. minutes, I would find the measure of the Hypothenusa C B, and the Angles B C.

The Equinoctial Elevated, as before, I make A B Base, and C A Perpendicular, counting in the first Meridian from the Equinoctial 79. degrees 15. minutes, and there I make a prick: Then I number in the Equinoctial from the first Meridian 23. degrees 8. minutes, the length of the Perpendicular, and there I make a second Prick: This prick I bring to the Brasen Meridian, so is the first Meridian separated from the Brasen Meridian so many degrees and minutes as is the length of the Perpendicular C A; Then I screw the Quadrant of Altitude to the *Zenith*, *viz.* directly over the Equinoctial, and move it about till the edge of it touch the Prick made in the first Meridian: So is the Triangle made on the Globe: And the number of degrees and minutes of the Quadrant of Altitude comprehended between the first Meridian and the *Zenith* is the measure of the Hypothenusa C B; which in this Example is 80. degrees 8. minutes: The number of degrees in the Horizon comprehended



hended between the Equinoctial and the Quadrant of Altitude is the measure of the Angle C, 85. degrees 44. minutes: the Angle A is a Right Angle, 90. degrees: And to find the Angle B, turn the Triangle, (all but the Letters;) Thus: As before A C was Base, so now I make B A Base; and as before A B was Perpendicular, so now C A shall be Perpendicular: so is your Triangle turned.




Now, as before I counted 79. degrees 15. minutes from the Equinoctial on the first Meridian, which was the length of that Base, so now I count 23. degrees 8. minutes on the first Meridian, which is the length of this Base, and there (as before) I make a Prick: and as before I counted 23. degrees 8. minutes on the Equinoctial from the first Meridian, which was the length of that Perpendicular; so now I count 79. degrees 15. minutes on the Equinoctial, which is the length of this Perpendicular; and there I make a prick on the Equinoctial: Then I bring this Prick (as before) to the Brasen Meridian, so shall the first Meridian be distant (as before) from the Brasen Meridian so many degrees and minutes as is the length of this Perpendicular, *viz.* 79. degrees 15. minutes. Then Having the Quadrant of Altitude screwed to the *Zenith*, I turn it about till the edge of it touch the Prick made in the first Meridian at 23. degrees 8. minutes distant from the Equinoctial; so is the Triangle Turned: And so shall the Arch of the Horizon comprehended between the Equinoctial and the Quadrant of Altitude be the measure of the Angle C in the former Triangle, (but now made B) 23. degrees 30. minutes: you also see again the measure of the Hypothenusa B C 80. degrees 8. minutes on the Quadrant of Altitude, counted between the *Zenith* and the first Meridian.

PROB.

## Prob. II.

### *A* Leg *and the* Hypothenuſa *given, to find the Reſt.*

EXample. The Leg given ſhall be C A in the former Triangle, 23. degrees 8. minutes, The Hypothenuſa C B 80. degrees 8. minutes. The Equinoctial and Quadrant of Altitude Rectified, as by the laſt Probleme; Number the Leg C A 23. degrees 8. minutes on the Equinoctial from the firſt Meridian, and there make a prick; Bring this Prick to the Braſen Meridian; Then number on the Quadrant of Altitude the Hypothenuſa B C 80. degrees 8. minutes from the *Zenith* towards the Horizon, and make there on the edge of the Quadrant of Altitude another prick: Then turn the Quadrant of Altitude about till the prick made on the edge of it touch the firſt Meridian; ſo ſhall the Triangle be made: The arch of the Equinoctial comprehended between the firſt Meridian and the Braſen Meridian, ſhall repreſent A C the Perpendicular; the arch of the Quadrant of Altitude comprehended between the *Zenith* and the Firſt Meridian, ſhall repreſent B C the Hypothenuſa; and the arch of the firſt Meridian comprehended between the Equinoctial and the Quadrant of Altitude ſhall repreſent B A the Baſe; which was one Leg ſought, and is (as you will find) 79. degrees 15. minutes: The Angle C you will find in the Horizon 85. degrees 44. minutes: The angle A is the Right Angle 90. degrees: And to find the Angle B you muſt turn the Triangle, as you were directed in the former Probleme.

## Prob. III.

### *The* Hypothenuſa *and an* Angle *given, to find the Reſt.*

THe Hypothenuſa given ſhall be B C of the Triangle in Prob. 1. 80. degrees 8. minutes, The Angle given ſhall be C 85. degrees 44 minutes: The Globe and Quadrant of Altitude Rectified, as by Prob. 1. Count the given Angle 85. degrees 44. minutes on the Horizon from the Equinoctial, and there place the Quadrant of Altitude: Then turn about the Globe till the firſt Meridian touch 80. degrees 8.

minutes of the Quadrant of Altitude counted from the *Zenith* downwards, so shall the Triangle be made on the Globe: The Arch of the Equator comprehended between the first Meridian and the Brasen Meridian shall shew the length of the Perpendicular C A 23. degrees 8. minutes; the Arch of the first Meridian comprehended between the Equinoctial and the Quadrant of Altitude shall shew the length of the Base A B 79. degrees 15 minutes; the Right Angle made at the Intersection of the Brasen Meridian with the Equinoctial is 90. degrees: and to find the measure of the Angle B you must turn the Triangle, as you were directed Prob. 1.

## Prob. IIII.

### *A* Leg *and* Angle *adjoyning given, to find the Rest.*

IN the Triangle of Prob. 1. The Leg given shall be C A 23. degrees 8. minutes, the Angle adjoyning shall be C 85. degrees 44 minutes: The Globe and Quadrant of Altitude Rectified, as by Prob. 1. I turn about the Globe till the first Meridian be distant from the Brasen Meridian 23. degrees 8. minutes, the length of the Leg C A: Then I count in the Horizon from the Equinoctial 85. degrees 44. minutes, the measure of the Angle C; so is the Triangle made on the Globe. The Arch of the first Meridian comprehended between the Quadrant of Altitude and the Equinoctial shall shew the length of the Base A B 79. degrees 15. minutes; The Arch of the Quadrant of Altitude comprehended between the *Zenith* and the first Meridian shall shew the length of the Hypothenusa C B 80. degrees 8. minutes; The Right Angle made at the Intersection of the Equinoctial and the Brasen Meridian is 90. degrees: And to find the measure of the Angle B, you must turn the Triangle, as you were directed Prob. 1.

## Prob. V.

### *A* Leg *and the* Angle *opposite given, to find the Rest.*

IN the Triangle of Prob. 1. the Leg given shall be A B 79. degrees 15. minutes, the Angle opposite shall be C 85. degrees 44. mi-

44. minutes. The Globe and Quadrant of Altitude Rectified, as by Prob. 1. I bring the Quadrant of Altitude to 85. degrees 15 minutes of the Horizon, the measure of the Angle C: Then I turn the Globe till 79. degrees 15. minutes of the first Meridian (which is the measure of the Leg A B) touch the Quadrant of Altitude, so is the Triangle made on the Globe. The Arch of the Equinoctial comprehended between the first Meridian and the Brasen Meridian shews the length of the Leg C A 23. degrees 8. minutes; the Arch of the Quadrant of Altitude comprehended between the *Zenith* and the first Meridian, shall shew the length of the Hypothenusa C B 80. degrees 8. minutes. The Right Angle made at the Intersection of the Equinoctial and the Brasen Meridian is 90. degrees: And to find the measure of the Angle B, you must turn the Triangle, as you were directed in Prob. 1.

## Prob. VI.

### *The* Angle *given, to find the* Sides.

IN this Case you must turn the Angles into Sides, making an Oblique Triangle on the Globe, whose Sides shall be equal to the given Angles: so shall the Angles of this Triangle found, be the measure of the Sides required.

### Example.

In the Triangle of Prob. 1. The Angle A is 90. degrees, the Angle B 23. degrees 30. minutes, the Angle C 85. degrees 44. minutes. The Globe and Quadrant of Altitude Rectified, as by Prob. 1. I set the Right Angle A 90. degrees on the Brasen Meridian, between the Pole and the Equinoctial; For the Angle B I number downwards on the Quadrant of Altitude 23. degrees 30. minutes, which shall be the side representing that Angle: for the Angle C I number on the first Meridian from the Pole towards the Equinoctial 85. degrees 44. minutes, which shall be the side representing that Angle: Then I turn the Globe and Quadrant of Altitude till I can joyn the 23. degrees 30. minutes counted before on the Quadrant of Altitude and this 85. degrees 44. minutes counted in the first Meridian together; So is a Tri-

angle made on the Globe; whose sides being equal to the Angles given, shall have its Angles equal to the sides required: Thus the Arch of the Equinoctial comprehended between the first Meridian and the Brasen Meridian shall be found 23. degrees 8. minutes, the measure of the side A C: The Arch of the Horizon contained between the nearest Pole and the Quadrant of Altitude shall be found 79. degrees 15. minutes, the measure of the side B A: And to find the Hypotenusa B C, you have now *Data's* enough, either to find it as by some of the former Problemes; or else you may find it by turning the Triangle, as by Prob. 1.

These Cases of Right Angled Spherical Triangles may be wrought otherwaies by the Globe, If you alter its Position; making the North or South points of the Horizon, *Zenith*; or else the Poles of the World, or the Poles of the *Ecliptick*; and use the Circle of Position instead of the first Meridian or Circles of Longitude: But these Instructions together with a little Practise, are (I judge) sufficient; Therefore I shall refer Varieties to the Studies of the Industrious Student.

# *Of* Oblique Triangles.

## Prob. VII.

### *The three* Sides *given, to find the* Angles.

ELevate the Pole of the Globe above the Horizon to the Complement of one of the given Sides, and screw the Quadrant of Altitude in the *Zenith*, so shall that given Side be comprehended between the Pole and the Quadrant of Altitude; Then count from the Pole upon the first Meridian the measure of the Second Side, and there make a prick; Count also from the *Zenith* upon the Quadrant of Altitude downwards the measure of the third Side, and make there on the edge of the Quadrant of Altitude another prick; Then turn the Globe and Quadrant of Altitude till you can joyn these two pricks together; so shall your Triangle be made on the Globe: And then the number of degrees of the Equinoctial comprehended between the first Meridian

an and the Braſen Meridian ſhall be the meaſure of the Angle at the Pole: The Arch of the Horizon comprehended between the Quadrant of Altitude and the interſection of the Braſen Meridian with the Horizon on that ſide the Pole is elevated, ſhall be the meaſure of the ſecond Angle: And for finding the third Angle, you muſt turn the Triangle, as by Prob. 1.

## Example.

In the Triangle A B C annexed, The Side A B contains 38. degrees 30. minutes, the ſide B C 25. degrees, and the ſide A C 60. degrees; I would meaſure theſe Angles; I place one of theſe ſides upon the Meridian, *viz.* A B 38. degrees 30 minutes, the Complement of 38. degrees 30. minutes is 51 degrees 30. minutes; Therefore

I Elevate the Pole 51. degrees 30. minutes above the Horizon, ſo ſhall the *Zenith* be diſtant from the Pole 38. degrees 30. minutes; here I ſcrew the Quadrant of Altitude and count downwards on it the meaſure of the ſide B C 25. degrees, and there I make a prick: Then from the Pole I count on the firſt Meridian 60. degrees, the meaſure of the ſide A C, and there I make another prick: Then I turn the Globe and Quadrant of Altitude backwards or forwards till theſe two pricks are joyned together; ſo ſhall the Triangle A B C be made on the Globe: The arch of the Braſen Meridian comprehended between the Poſe and *Zenith* ſhall repreſent the ſide A B; the Arch of the Quadrant of Altitude comprehended between the firſt Meridian and the Braſen Meridian ſhall repreſent the ſide B C; and the Arch of the firſt Meridian comprehended between the Poſe and the Quadrant of Altitude ſhall repreſent the ſide A C; The Pole ſhall repreſent the Angle A, the *Zenith* the Angle B; and the interſection of the firſt Meridian with the Quadrant of Altitude ſhall repreſent the Angle C. The Angle at the Pole is meaſured in the Equator; for the degrees comprehended between the firſt Meridian and the Braſen Meridian being 17. degrees 15. minutes ſhews 17. degrees 15. minutes to be the meaſure of the Angle A: The Angle at the *Zenith* is meaſured in the Horizon; for the

the degrees comprehended between the Interſection of the Braſen Meridian with the Horizon on that ſide the Pole is Elevated being 142. degrees 42. minutes, ſhews that 142. degrees 42. minutes is the meaſure of the Angle B. Thus two angles are found; the third is wanting: which I find thus,

I turn the Triangle, placing either A or C in the *Zenith*. *Example:* I place A at the *Zenith*, which before was at the Pole; ſo ſhall C be at the Pole, and B at the Interſection of the firſt Meridian and the Quadrant of Altitude, and the ſide A C ſhall be comprehended between the Pole and *Zenith*: The ſide A C contains 60. degrees; its Complement to 90. is 30. degrees; therefore I Elevate the Pole of the Globe 30. degrees above the Horizon; ſo ſhall 60. degrees be in the *Zenith*; therefore to 60. degrees I ſcrew the Quadrant of Altitude and count on it downwards the meaſure of the other ſide next the *Zenith*, *viz.* 38. degrees 30. minutes, and there I make a prick: Then from the Pole on the firſt Meridian I count the meaſure of the laſt ſide, *viz.* 25. degrees, and there I make another prick; Then I turn the Globe and Quadrant of Altitude (as before) till theſe two pricks joyn; ſo is the Triangle altered on the Globe. For the Arch of the Braſen Meridian comprehended between the Pole and *Zenith* which before was 38. degrees 30. minutes, is now 60. degrees; the Arch of the Quadrant of Altitude Comprehended between the firſt Meridian and the Braſen Meridian, which before was 25. degrees, is now 38. degrees 30. minutes; and the Arch of the firſt Meridian comprehended between the Quadrant of Altitude and the Pole, which before was 60. degrees, is now 25. degrees. Thus the Angle C being now at the Pole, its meaſure is found in the Equinoctial, *viz.* that Arch comprehended between the firſt Meridian and the Braſen Meridian, which is 25. degrees 24. minutes; and the meaſure of the Angle A, which is now in the *Zenith*, having its ſides, the one an Arch of the Braſen Meridian, the other an *Azimuth*, (or which is all one) an Arch of the Quadrant of Altitude, is meaſured in the Horizon, as all *Azimuths* are, and found 17. degrees 15. minutes, as before,

PROB.

## Prob. VIII.

*Two* Sides *and the* Angle *contained between them given, to find the Reſt.*

Example, In the former Triangle I have given the ſides A B, 38. degrees 30. minutes, A C, 60. degrees, and the Angle A 17. degrees 15. minutes.

The Method I have hitherto uſed is to place the given ſide upon the Meridian between the Pole and *Zenith*; but becauſe the Angle at the Pole in this Example falls out ſo large that the Quadrant of Altitude will not reach the firſt Meridian; therefore I ſhall uſe another way to work this Probleme as well.

I 'Elevate the Pole of the Globe to the Com-plement of one of the given ſides; ſuppoſe the ſide A B, which being 38. degrees 30. minutes, its Complement to 90. degrees is 51. degrees 30. minutes, ſo ſhall the *Zenith* be diſtant from the Pole 38. degrees 30. minutes, the meaſure of the ſide A B: The other ſide is 60. degrees, this 60. degrees I count from the Pole in the firſt Meridian, and there I make a prick: The Angle given is 17. degrees 15. minutes; this I count in the Equinoctial from the firſt Meridian, and this degree and minute in the Equinoctial I bring to the Braſen Meridian, ſo ſhall the firſt Meridian be ſeparated from the Braſen Meridian 17. degrees 15. minutes: Then I ſcrew the Quadrant of Altitude to the *Zenith*, and bring the ſide of it to the prick made in the firſt Meridian: ſo ſhall the Triangle be made on the Globe. Then to find the unknown ſide B C, I count the number of degrees on the Quadrant of Altitude comprehended between the *Zenith* and the firſt Meridian, and find 25. degrees, which is the meaſure of the ſide B C: To find the meaſure of the Angle B, I count the number of degrees contained between the Interſection of the Meridian with the Horizon on that ſide the Pole is Elevated and the Quadrant of Altitude, and find 142. degrees 42. minutes, which is the meaſure of the Angle B: And to find the Angle C I turn the Triangle, as in Prob. 7.

## Prob. IX.

*Two* Sides *and an* Angle *oppoſite to one of them given, to find the Reſt.*

Example. In the Triangle in Prob. 7. the Sides given are A B 38. degrees 30. minutes, and A C 60. degrees: The Angle given oppoſite to A C is B 142. degrees 42. minutes: I Elevate the Pole to the Complement of one of the given ſides; ſuppoſe A B, which being 38. degrees 30. minutes, its Complement to 90. degrees is 51. degrees 30. minutes; ſo is the *Zenith* diſtant from the Pole 38. degrees 30. minutes: To this 38. degrees 30. minutes I ſcrew the Quadrant of Altitude, and count in the Horizon from the Interſection of the Meridian with the Horizon on that ſide the Pole is Elevated the meaſure of the given Angle B, *viz.* 142 degrees 42. minutes, and to this number of degrees and minutes of the Horizon I bring the edge of the Quadrant of Altitude, then I count in the firſt Meridian from the Pole the meaſure of the ſide A C 60. degrees; and there I make a prick, and turn about the Globe till that prick come to the edge of the Quadrant of Altitude, ſo is the Triangle made on the Globe. The degrees of the Quadrant of Altitude comprehended between the firſt Meridian and the *Zenith* being 25. degrees, is the meaſure of the ſide B C: The degrees of the Equinoctial comprehended between the firſt Meridian and the Braſen Meridian being 17. degrees 15. minutes, is the meaſure of the Angle A; and for finding the meaſure of the Angle C, I turn the Triangle, as in Prob. 7.

## Prob. X.

*Two* Angles *and the* Side *comprehended between them given, to find the Reſt.*

Example, In the Triangle of Prob. 7. the Angles given are A 17 degrees 15. minutes, and B 142. degrees 42. minutes, the ſide comprehended between them is A B 38. degrees 30. minutes; I Elevate the Pole to the Complement of the ſide A B which being 38. degrees 30. minutes, its Complement to 90 degrees

grees is 51. degrees 30. minutes, ſo is the *Zenith* diſtant from the Pole 38. degrees 30. minutes; to this 38. degrees 30. minutes I ſcrew the Quadrant of Altitude, and count in the Horizon from the Interſection of the Meridian with the Horizon on that ſide the Pole is Elevated the meaſure of the given Angle B, *viz.* 142. degrees 42. minutes, and to this number of degrees and minutes of the Horizon I bring the edge of the Quadrant of Altitude; then I turn about the Globe till the firſt Meridian is diſtant from the Braſen Meridian 17. degrees 15. minutes of the Equinoctial, which is the meaſure of the other given Angle; So ſhall the Triangle be made on the Globe: and the Arch of the Quadrant of Altitude comprehended between the firſt Meridian and the *Zenith* ſhall be the meaſure of the ſide B C 25. degrees, and the Arch of the firſt Meridian comprehended between the Pole and its Interſection with the Quadrant of Altitude ſhall be the meaſure of the ſide A C 60. degrees: The meaſure of the Angle C is found by turning the Triangle, as in Prob. 7.

## Prob. XI.

### *Two* Angles *and a* Side *oppoſite to one of them given, to find the Reſt.*

Example. In the Triangle of Prob. 7. the Angles given are A 17. degrees 15 minutes, and B 142. degrees 42. minutes, the ſide given is B C 25. degrees, being the ſide oppoſite to the Angle A; the Angle A is made at the Pole of the Globe, and meaſured in the Equator: Therefore I ſeparate the firſt Meridian from the Braſen Meridian 17. degrees 15. minutes, ſo doth the Pole repreſent the Angle A; the Angle B is made at the *Zenith*, and meaſured in the Horizon; therefore I count in the Horizon 142. degrees 42. minutes, and there I make a prick, to this prick I bring the edge of the lower end of the Quadrant of Altitude, (not minding to what degrees of the Meridian the upper end of it is placed) Then I count from the upper end of the Quadrant of Altitude 25. degrees downwards the meaſure of the ſide B C and there I make a prick, and keeping the lower end of the Quadrant of Altitude to the prick made in the Horizon, I ſlide the upper end of it forwards or backwards till the prick on the Quadrant of Altitude come to the firſt Meridian, ſo ſhall the Triangle be made

on the Globe: Then the Arch of the Braſen Meridian comprehended between the Pole and the upper end of the Quadrant of Altitude ſhall be the meaſure of the ſide A B 38. degrees 30. minutes; and the Arch of the firſt Meridian comprehended between the prick on the Quadrant of Altitude and the Pole ſhall be the meaſure of the ſide A C 60. degrees; But the Angle C you muſt find by turning the Triangle; as in Prob. 7.

In the working this Probleme I would have placed the given ſide B C 25. degrees upon the Braſen Meridian between the Pole and *Zenith*; but then the Angle B (being ſo Obtuſe) would have had that ſide which would be interſected by the Quadrant of Altitude (*viz.* the firſt Meridian) under the Horizon, which the Quadrant of Altitude cannot reach.

## PROB. XII.

### *Three* Angles *given, to find the* Sides.

THis Triangle is taught to be reſolved by Mr *Palmer* on the *Planiſphear*; Book 3. Chap. 19.

It is to be known (ſaith he) That if you go to the Poles of the three great Circles whereof your Triangle is made, theſe Poles ſhall be the Angular points of a ſecond Triangle; and the two leſſer ſides of this ſecond Triangle ſhall be equal to the two leſſer Angles of your firſt Triangle: the greateſt ſide of the ſecond Triangle ſhall be the ſupplement of the greateſt Angle of the firſt Triangle (that is, ſhall have as many degrees and minutes as the greateſt Angle of the firſt Triangle wanted of 180. degrees (ſee *Pitiſcus Trigonometry Lib.* 1. *Prop.* 61.

This ſecond Triangle therefore (all whoſe ſides are known from the Angles of the firſt) you ſhall reſolve by Prob. 7. And having by that Probleme found the Angles of this ſecond Triangle, know that the two leſſer Angles of the ſecond Triangle ſhall be ſeveral and reſpectively equal to the two leſſer ſides of the firſt Triangle, (and the leaſt Angle to the leaſt ſide, the middle Angle to the middle ſide) and the greateſt Angle of this ſecond Triangle being ſubtracted out of 180. degrees, ſhall leave you the greateſt ſide of your firſt Triangle.

Example. If the Angles be given 142. degrees 42. minutes, 17. degrees 15. minutes, and 25. degrees 24. minutes; and the

ſides

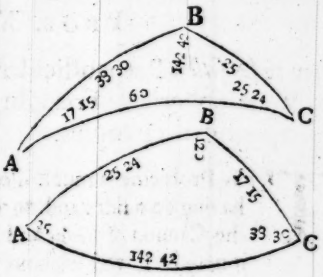
ſides be enquired. Draw by aim a rude Scheam of this firſt Triangle, writing in the Angle A 17 degrees 15. minutes, in B 142. degrees 42. minutes, in C 25. degrees 24. minutes; ſuppoſing the ſides yet unknown: then draw under this by aim alſo, a Scheam of the ſecond Triangle, ſetting his Baſe Parallel with the Baſe of the firſt. and making the Baſe of the ſecond ſhotter then the Baſe of the firſt. Set alſo B at the Vertical Angle, and A C at the Baſe; as in the firſt Triangle. Then ſay,

Becauſe A in the firſt Triangle is 17. degrees 15. minutes, therefore in the ſecond Triangle B C (which ſubtendeth A) ſhall be 17. degrees 15. minutes: and becauſe C in the firſt Triangle is 25. degrees 24. minutes, therefore in the ſecond Triangle the ſide A B (which ſubtendeth C) ſhall be 25. degrees 24. minutes; and becauſe B the greateſt Angle in the firſt Triangle, is 142. degrees 42. minutes, therefore in the ſecond Triangle the ſide A C (which ſubtendeth B) ſhall be the complement thereof to 180. degrees, *viz.* 37. degrees 18. minutes: Write now upon the ſides of this ſecond Triangle the quantities of the ſides, ſo is your ſecond Triangle ready to be reſolved, as by Prob. 7. Whereby you ſhall find the Angles of the ſecond Triangle, as I have expreſſed them in the Scheam. A 25. degrees, C 38. degrees 30. minutes, B 120. degrees.

Now laſtly, I ſay theſe Angles of the ſecond Triangle thus found, give me the ſides of the firſt Triangle, which I ſeek, in this manner.

| In the ſecond Triangle. | | In the firſt Triangle. | |
|---|---|---|---|
| A is 25. degrees | | B C is 25. degrees | |
| C is 38. 30. | Therefore | A B 38. 30. | |
| B is 120. 00. | | A C 60. 00. | Complement |

of 120. degrees to 180. And thus by all the Angles given, we have found out all the ſides, which was required.




Having then the Angles of your firſt Triangle given, and his ſides now found; you ſhall find his ſcituation on the Globe thus: Place him as in Prob. 7. A B 38. degrees 30. minutes between

the Pole and *Zenith*, A C 60. degrees in the first Meridian separated from the Brasen Meridian 17. degrees 15. minutes of the Equinoctial, B C 25. degrees on the Quadrant of Altitude, counted from the *Zenith* when its lower end is applyed to the 142. degrees 42. minutes of the Horizon: you shall say, Because the East point of the Horizon is the Pole of the Arch A B, therefore at the East point of the Horizon shall stand the Angle C, which A B subtendeth: Next follow the 142. degrees 42. minutes of *Azimuth* which maketh B C of your Triangle to the Horizon, and from thence number in the Horizon towards the East point 37, degrees 18. minutes, the Complement of the Angle A to 180. degrees, and number yet further 52. degrees 42. minutes beyond the East point to make up 90, and there is the Pole of the Arch B C: Therefore there shall stand the Angle A, which B C subtendeth. Then count in the Equator from the first Meridian 90. degrees, which will end under the Horizon, and there make a prick; for there is the Pole of the Arch or side A C. Therefore at that prick shall stand the Angle B, which A C subtendeth.

Here you see your second Triangle made by the Poles of the first adjoyning to the East point of the Globe: only the side A B is wanting: To get that, make a prick upon the Globe against the 52. degres 42. minutes from the East point of the Horizon found before, to represent the Angle A: Then turn about the Globe and Qudrant of Altitude till that prick and the prick made before for the Angle B are both at once cut by the side of the Quadrant of Altitude, and you will find 25. degrees 24. minutes of the Quadrant of Altitude comprehended between the two pricks, for the measure of the side A B.

## Prob. XIII.

### *How to let fall a* Perpendicular *that shall divide any* Oblique Spherical Triangle *into two* Right Angled Spherical Triangles.

This Probleme is much used when an Oblique Triangle having two sides and an Angle given is to be solved by the Cannon of *Sines* and *Tangents*: but by the Globe it may be solved without it, as was shewed Prob, 8, 9.

Yet

Yet becauſe letting fall a Perperdicular is ſo frequent in all Authors that treat of *Trigonometry*, I have inſerted this Probleme alſo.

In the Oblique Triangle of the fromer Problemes there is given the ſides A B 38 $\frac{1}{2}$ degrees, and B C 25. degrees, and the Angle C 25. degrees 24. minutes; It is required to let fall a Perpendicular as B *a* from the Angle B, upon the Baſe A C; and to know both the meaſure of this Perpendicular, and the parts it divides the Baſe into.

Therefore Elevate the Pole of the Globe above the Horizon ſo much as is the meaſure of the Angle C, which in this Example is 25. degrees 24. minutes, and bring the interſection of the firſt Meridian with the Equinoctial to the Eaſt point of the Horizon; ſo ſhall the Angle at the Eaſt point of the Horizon comprehended between the Horizon and the firſt Meridian be equal to the Angle C: then count in the firſt Meridian from the Eaſt point of the Horizon the meaſure of the ſide B C 25. degrees, and having the Quadrant of Altitude ſcrewed to the *Zenith* bring the graduated edge of it to theſe 25. degrees, ſo ſhall the Arch of the Horizon comprehended between the Eaſt point and the lower end of the Quadrant of Altitude be the number of degrees that the Perpendicular falls upon the Baſe, counted from the Angle C to *a*, which in this Example is 21 $\frac{3}{4}$ degrees, and the Arch of the Quadrant of Altitude comprehended between the Horizon and the firſt Meridian is the meaſure of the Perpendicular B *a* 11. degrees.

And thus by letting fall this Perpendicular you have two Right angled Spherical Triangles made, the one B *a* C, wherein is found C *a*, 21 $\frac{3}{4}$ degrees, B C 25. degrees B *a* 11. degrees C 25. degrees 24. minutes, and *a* the Right Angle: There remains only the angle B unknown; which you muſt find by turning the Triangle, as was taught Prob. 1. The other Right angled Spherical Triangle made, is B *a* A, wherein is found A *a* (Complement of 21 $\frac{3}{4}$ degrees to 60 degrees (the whole Baſe before given) 38 $\frac{1}{4}$ degrees, A B 38. degrees 30. minutes, B *a* 11. degrees, and *a* the Right Angle; which is more then enough to find the Angles A and B; as was ſhewed in the *Preface. Theorem* 1.

*The End of the Sixth Book.*

# Here follows the *Ancient* *STORIES of the ſeveral* STARS, *and* CONSTELLATIONS.

Shewing the Poetical Reaſons why ſuch Various Figures are placed in *HEAVEN.*

*Collected from* Dr HOOD.

And Firſt,

*Of the* Northern Conſtellations.

1. URSA MINOR. This Conſtellation hath the preheminence, becauſe it is neereſt of all the reſt unto the North Pole; And is called of the Greeks Ἄρκτος whereupon the Pole is called the Pole Arctick, for that it is neer unto that Conſtellation. It is alſo called *Helice minor*, becauſe of the ſmal revolution which it maketh round about the Pole: or rather of *Elice*, a Town in *Arcadia*, wherein *Calyſto* the great Bear, and mother to the leſs, was bred. It is called *Cynoſura*, becauſe this Conſtellation, though it carry the name of a Bear, yet it hath the taile of a Dog: Laſt of all, it is termed *Phœnice*, becauſe that *Thales*, who firſt gave the name to this Conſtellation, was, a *Phœnician*: And therefore the *Phœnicians* being taught how to uſe it in their Navigations, did call it by the name of the Country wherein *Thales* was born. It conſiſteth of 7. ſtars, which the Latines call *Septemtriones*; becauſe by their continual motion, thoſe ſeven ſtars do as it were wear the Heavens. The *Spaniards* call them all *Boſina*, that is, an *Horn*; becauſe they may be very well brought into that form; whereof that which is in the end of the tail, is called the *Pole-ſtar*, by reaſon of the neareneſs thereof unto the Pole of the world: for it is diſtant (according to the opinion of moſt) from the true Pole, but 23. deg. 30. min. The Arabians call

call it *Alrukaba*: And of the *Scythians* it is ſaid to be an *Iron nail*, and is worſhipped by them as a God. The two ſtars that are in the ſholders of the *Bear*, are called *Guards*, of the Spaniſh word *Guardare*, which is to behold; becauſe they are diligently to be looked unto, in regard of the ſingular uſe which they have in Navigation.

The reaſon why this Conſtellation was brought into the Heavens, is diverſly ſet down, and firſt in this manner: *Saturn* having received of the Oracle that one of his Sons ſhould baniſh him out of his kingdom, determined with himſelfe to kill all the men children that he ſhould beget: whereupon he gave command to *Ops* his wife, being then great, that ſhe ſhould ſhew him the child ſo ſoon as ever it was born: But ſhe bringing forth *Jupiter*, and being greatly delighted with his hair, gave the child unto two Nymphs of *Crete*, dwelling in the mount *Dicte*; whereof this was one, and was called *Cynoſura*; the other was *Helice*.

*Jupter*, after that (according to the Oracle) he had bereft his Father of the kingdom, in recompence of their paines and courteſie, tranſlated them both into the Heavens, and made of them two Conſtellations; the *Leſſer Bear*, and the *Greater Bear*.

Otherſome ſay that it was *Arcas*, the ſon of *Calyſto*; and they tell the tale on this manner. *Calyſto* a Nimph of ſingular beauty, daughter to *Lycaon* King of *Arcadia*, induced by the great deſire ſhe had of hunting, became a follower of the Goddeſs *Diana*. After this, *Jupiter* being enamored with her beauty, and out of hope, by reaſon of her profeſſion, to win her love in his own perſon, counterfeited the ſhape of *Diana*, lay with *Calyſto*, and got her with child; of whom was born a ſon, which was called *Arcas*. *Diana*, or rather *Juno*, being very much offended here-with, turned *Caliſto* into a *Bear*. *Arcas* her ſon at the Age of fifteen, hunting in the woods, by chance lighted upon his mother in the ſhape of a *Bear*: who knowing her ſon *Arcas*, ſtood ſtil, that he might come near unto her, and not be afraid: but he fearing the ſhape of ſo cruel a Beaſt, bent his bow of purpoſe to have ſlain her: Whereupon *Jupiter* to prevent the miſchief, tranſlated them both into Heaven, and of them made two ſeveral Conſtellations: unto the *leſſer Bear*, there belongs but one ſtar unformed.

2. URSA MAIOR, the *Greater Bear*, called alſo of the Greeks *Arctos*, and *Helice*, conſiſteth of 27. ſtars: Among the

which, those seven that are in the hinder part and tail of the Bear, are most observed; the Latines call them *Plaustrum*; and of our men they are called *Charles Wayn*; because the stars do stand in such sort, that the three which are in the tail resemble the Horses, and the other four which are in the flank of the *Bear*, stand (after a manner) like the Wheels of a Waggon, or Chariot; and they are supposed by some to be greater then the Sun. The reason of the Translation of this Constellation into the Heaven, is at large set down in the other Constellation, and therefore needs not here to be repeated. This Constellation was first invented by *Nauplius*, the Father of *Palamedes* the Greek: and in great use among the Grecians; and this is to be noted both in this and the former Constellation, that *they never set under the Horizon, in any part of Europe*: which though it fall out by reason of their scituation in the Heavens; yet the Poets say, that it came to pass through the displeasure and hatred of *Juno*; who for that she was by *Calisto* made a Cuckquean, and they notwithstanding (as she took it) in dispight of her, were translated into Heaven, requested her brother *Neptune*, that he should never suffer those Stars to set within his Kingdom: To which request *Neptune* condiscended; so that in all *Europe* they never come neer unto the Sea, or touch the Horizon. If any one marvel, that (seeing she hath the form of a *Bear*) she should have a tail so long; Imagine that *Jupiter* fearing to come too nigh unto her teeth, laid hold on her tail, and thereby drew her up into heaven; so that she of her selfe being very weighty, and the distance from the Earth to the Heaven very great, there was great likelyhood that her tail must stretch.

The unformed stars belonging to this Constellation are eight.

3 DRACO, the *Dragon*, of some named the *Serpent*; of others the *Snake*, by the *Arabians*, *Aben*; and by *Junctinus Florentinus*, *Vrago*; because he windeth his tail round about the Ecliptick Pole; it containeth 31. stars. This was the Dragon that kept the Golden Apples in the Orchard of the Hesperides, (now thought to be the Islands of *Cape de Virde*) and for his diligence and watchfulness, was afterwards translated into heaven: Yet others say that he came into Heaven by this occasion; when *Minerva* withstood the *Gyants* fighting against the *Gods*; they to terrifie her, threw at her a mighty *Dragon*; but she catching him in her hands, threw him presently up into Heaven, and placed him there, as a memorial of that her resistance. Others would

would have it to be the Serpent *Python*, whom *Apollo* slew, after the Deluge.

4. CEPHUS, containeth in him 11. stars, and hath two unformed. This was a King of the *Æthiopians*, and Husband unto *Cassiopeia*, and father of *Andromeda*, whom *Perseus* married. He was taken up into Heaven, with his wife and daughter, for the good deeds of *Perseus* his son in law; that he and his whole stock might be had in remembrance for ever. The Star which is in his right shoulder, is called by the Arabians *Alderahiemin*; *i.e.* his right Arm.

5 BOOTES, *the driver of the Oxen* (for so I suppose the name to signifie, rather then an *Herdsman*; for he hath not his name because he hath the care of any Cattle, but only because he is supposed to drive *Charles his Wain*, which is drawn by 3. Oxen) he is also called *Arctophilax*, the *keeper* of the *Bear*, as though the care of her were committed to him. This Constellation consisteth of 22 Stars. Some will have *Bootes* to be *Arcas*, the Son of her who before was turned into the *Great Bear*; and they tell the Tale thus: *Lycaon* the Father of *Calisto*, receiving *Jupiter* into his house as a guest, took *Arcas* his daughters son, and cut him in pieces; and among other Services, set him before *Jupiter* to be eaten: for by this means he thought to prove if his guest were a God, as he pretended to be. *Jupiter* perceiving this heinous fact, overthrew the table, fired the house with lightning, and turned *Lycaon* into a wolf: but gathering and setting together again the limbs of the child, he commited him to a Nymph of *Ætolia* to be kept: *Arcas* afterwards coming to mans estate, and hunting in the woods, lighted at unawares upon his mother, transformed by *Juno* into the shape of a *Bear*, whom he persued into the Temple of *Jupiter Lycæus*, whereunto by the law of the *Arcadians*, it was death for any man to come. For as much therefore as they must of likelyhood be both slain, *Calysto* by her son, and he by the Law; *Jupiter* to avoid this mischief, of meer pitty took them both up into heaven. Unto this Constellation belongeth but one star unformed, and it is between the legs of *Bootes*, and by the *Grecians* it is called *Arcturus*, because of all the stars neer the *great Bear* named *Arctos*, this star is first seen neer her tail in the evening. The Poetical invention is thus.

*Icarus* the father of *Erigone*, having received of the God

*Bacchus* a Flagon of wine, to declare how good it was for mortal men, travelled therewith into the Territories of *Athens*, and there began to carouſe with certain ſhepheards: they being greatly delighted with the pleaſantneſs of the wine, being a new kind of liquor, began to draw ſo hard at it, that ere they left off, they were paſt one and thirty; and in the end, were fain to lay their heads to reſt. But coming unto themſelves again, and finding their brains ſcarce in good temper, they killed *Icarus*, thinking indeed that he had either poyſoned them, or at the leaſt-wiſe made their brains intoxicate. *Erigone* was ready to die for grief, and ſo was *Mera*, her little dog. But *Jupiter* to allay their grief, placed her father in Heaven, between the legs of *Arctophilax*.

6. CORONA BOREA, the *Northern garland*, conſiſteth of eight ſtars; yet *Ovid* ſaith, that it hath nine. This was the Garland that *Venus* gave unto *Ariadne*, when ſhe was married unto *Bacchus*, in the Iſle *Naxus*, after that *Theſeus* had forſaken her: which Garland, *Bacchus* placed in the Heaven, as a token of his love. *Novidius* will have it to be the *Crown of the Virgin Mary*.

7. ENGONASIS: This Conſtellation hath the name, becauſe it is expreſſed under the ſhape of a man kneeling upon the one knee, and is therefore by the Latines called *Ingeniculum*. It containeth 29. ſtars, and wanteth a proper name, becauſe of the great diverſity of opinions concerning the ſame. For ſome will have it to be *Hercules*, that mighty Conquerer, who for his 12. labours was thought worthy to be placed in the heaven, and nigh unto the *Dragon* whom he overcame. Others tell the tale thus: That when the *Tytans* fought againſt the *Gods*, they for fear of the *Gyants*, ran all unto the one ſide of the heaven: whereupon the Heaven was ready to have fallen, had not *Hercules* together with *Atlas* ſet his neck unto it, and ſtayed the fall: and for this deſert, he was placed in the Heaven.

8 LYRA, the *Harp*, it containeth 10. ſtars; whereof thus goeth the Fable. The River *Nilus* ſwelling above his banks, overflowed the Country of *Ægypt*; after the fall whereof there were left in the fields divers kinds of living things, and amongſt the reſt a *Tortoiſe*; *Mercury*, after the fleſh thereof was conſumed, the ſinews ſtill remaining, found the ſame, and ſtriking it, he made it yeild a certain ſound; whereupon he made an *Harp* like unto it, having 3. ſtrings and gave it unto *Orpheus* the ſon of *Caſſiopea*.

This

This *Harp* was of ſuch excellent ſound, that Trees, Stons, Fowls, and wild Beaſts are ſaid to follow the ſound thereof. After ſuch time therefore that *Orpheus* was ſlain by the women of *Thrace*, the Muſes by the good leave of *Jupiter*, and at the requeſt of *Apollo*, placed this *Harp* in Heaven. *Novidius* will have it to be the *Harp* of *David*, whereby he pacified the evil ſpirit of *Saul*. This Conſtellation was afterwards called *Vultur Cadens*, the *falling Grype*: and *Falco*, the *Falcon*; or *Timpanum*, he *Timbrel*.

9 OLOR, or *Cygnus*, the *Swan*, called of the Caldæans *Adigege*: it hath 17. ſtars: of this Conſtellation the Poets Fable in this manner. *Jupiter* being overtaken with the love of *Læda*, the wife of *Tyndarus* King of *Oebalia*, and knowing no honeſter way to accompliſh his deſire, procured *Venus* to turn her ſelfe into an *Eagle*, and himſelf he turned into the ſhape of a *Swan*: Flying therefore from the *Eagle*, as from his natural enemy, that earneſtly purſued him, he lighted of purpoſe in the lap of *Leda*, and, as it were, for his more ſafety, crept into her boſome. The woman not knowing who it was under that ſhape, but holding (as ſhe thought) the *Swan* faſt in her armes, fell a ſleep: In the mean while *Jupiter* enjoyed his pleaſure; and having obtained that he came for, betook him again unto his wings; and in memorial of his purpoſe (attained under that form) he placed the *Swan* among the ſtars.

*Ovid* calleth this Conſtellation *Milvius*, the *Kite*, and telleth the tale thus. The Earth being greatly offended with *Jupiter*, becauſe he had driven *Saturn* his father out of his Kingdom, brought forth a monſtrous *Bull*, which in his hinder parts was like a *Serpent*; and was afterwards called the *Fatal-Bull*; becauſe the *Deſtinies* had thus decreed, that whoſoever could ſlay him, and offer up his entrails upon an Altar, ſhould overcome the eternal Gods. *Briarens* that mighty Gyant, and ancient enemy of the Gods overcame the Bull, and was ready to have offered up his entrails according to the decree of the *Deſtinies*: But *Jupiter* fearing the event, commanded the Fowls of the Air to ſnatch them away: which although to their power, they endavoured, yet there was none of them found ſo forward and apt to that action as the *Kite*, and for that cauſe he was accordingly rewarded with a place in Heaven. Some call this Conſtellation *Ornis*, that is, the *Bird*: others call it *Vultur volans*, the *Flying Grype*: It is alſo called *Gallina*, the *Hen*. Unto this Conſtellation do belong two unformed ſtars.

10. CAS

10. CASSIOPEIA, She consisteth of 13. Stars. This was the Wife of *Cepheus*, and mother of *Andromeda*, whom *Perseus* married, and for his sake was translated into Heaven, as some write. Others say that her beauty being singular, she waxed so proud, that she preferred her self before the *Nereides*, which were the *Nymphs of the Sea*: for which cause, unto her disgrace, and the example of all others that in pride of their hearts would advance themselves above their betters, she was placed in the Heaven with her head as it were downwards, so that in the revolution of the Heavens, she seemeth to be carried head-long.

11. PERSEUS, he hath 26. Stars. This was the Son of *Jupiter*, whom he in the likeness of a *Golden shower* begat upon *Danae*, the daughter of *Acrisius*. This *Perseus* coming unto mans estate, and being furnished with the Sword, Hat, and Wings of his brother *Mercury*, and the Shield of his sister *Minerva*, was sent by his foster-father *Polidectes*, to kill the Monster *Medusa*, whom he slew; and cuting off her head, carried it away with him: But as he was hastning homeward, flying in the Air, he espied *Andromeda* the daughter of *Cepheus* and *Cassiopeia*, for the pride of her mother, bound with a Chain unto a Rock, by the Sea side, there to be devoured by a Whale: *Perseus* taking notice and pitty of the case, undertook to fight with the *Monster*, upon condition that *Andromeda* might be his Wife; to be short, he delivered *Andromeda*, married her, and returning homeward unto the Isle *Seriphus*, he found there his Grand-father *Acrisius*, whom by mischance, and unadvisedly, he slew with a quoit: (or as *Ovid* reporteth, with the terrible sight of the horrible head of *Medusa*, not knowing that it was his Grand-father: but afterwards understanding whom he had slain, he pined away through extream sorrow: whereupon *Jupiter* his Father pitying his grief, took him up into Heaven, and there placed him in that form wherein he overcame *Medusa*, with the sword in one hand, and the head of *Medusa* in the other, and the Wings of *Mercury* at his Heels. This Constellation, because of the unluckiness thereof, is called by Astrologers *Cacodemon*, (*i.e.*) *Unlucky*, and *Unfortunate*. For (as they say) they have observed it, that whatsoever is born under this Constellation, having an evil Aspect, shall be stricken with sword, or loose his Head. *Novidius* saith that it is *David* with *Goliah* his head in the one hand, and his sword in the other. The unformed Stars belonging unto this Constellation, are three.

12. Au-

12. AURIGA, the *Waggoner*, or *Carter*: he consisteth of 14. Stars; the *Arabians* call him *Alaiot*; the *Greeks Heniochus*, *i. e.* a man holding a bridle in his hand, and so is he pictured. *Eratosthenes* affirmeth him to be *Erichthonious* King of *Athens*, the son of *Vulcane*: who having most deformed feet, devised first the use of the Wagon or Chariot, and joyned horses together to draw the same, to the end that he sitting therein, might the better conceal his deformities. For which invention, *Jupiter* translated him into the Heavens.

In this Constellation there are two other particular Constellations to be noted; whereof the one consisteth but of one Star alone, which is in the left shoulder of *Auriga*, and is called *Hircus*, or *Capra* the *Goat*; the *Arabians* call it *Alhaioth*: The other consisteth of two little Stars a little beneath the other, standing as it were in the hand of *Auriga*; this Constellation is called *Hadi*, the *Kids*. The tale is thus; *Saturn* (as you heard before) had received of the Oracle, that one of his sons should put him out of his Kingdom, whereupon he determined to devoure them all: *Ops* by stealth conveyed away *Jupiter*, and sent him to *Melissus* King of *Crete*, to be nourished: *Melissus* having two daughters, *Amalthaa* and *Melissa*, committed *Jupiter* unto their Nursery; *Amalthaa* had a *Goat* that gave suck unto two *Kids*, so that by the milk of this *Goat*, she nourished *Jupiter* very well. To requite this her care and courtesie, *Jupiter* (after he had put his Father out his Kingdom) translated her *Goat* and her two *Kids* into Heaven; and in remembrance of the Nurse, the *Goat* is called *Capra Amalthaa*. *Novidius* saith, that when Christ was born, and his birth made manifest by the Angels unto the Shepherds, one of them brought with him for a Present, a Goat and two young Kids; which in token of his good will, were placed in Heaven.

13. OPHIUCHUS, or SERPENTARIUS, That is, the *Serpent-bearer*. This Constellation hath no proper name, but is thus entituled, because he holdeth a Serpent in his hands. It containeth 24. Stars. Some say that it is *Hercules*, and report the tale on this manner *Juno* being a great enemy to *Hercules*, sent two snakes to kill him as he lay sleeping in his Cradle: but *Hercules* being a lusty Child (for *Jupiter* had spent two daies in begetting him) without much ado strangled them both: In memorial of so strange an event, *Jupiter* placed him in the Heavens, with a Serpent in his hands,

14. SER-

14. SERPENS, the *Serpent* of *Ophiuchus*, which consisteth of 18. Stars. Some say that it is one of the Serpents that should have slain *Hercules* in his Cradle. *Novidius* saith, it is the *Viper* that bit *Paul* by the hand. Others deliver the tale in these words; *Glaucus* the son of *Minos* King of *Crete*, was by misfortune drowned in a Barrel of Honey: *Minos* his father craved the help of *Æsculapius* the Physitian: and that he might be driven perforce to help the child, he shut him up in a secret place, together with the dead carcass: whiles *Æsculapius* stood in a great maze with himself what were best to be done, upon a sudden there came a Serpent creeping towards him; the which Serpent he slew with the staff which he had in his hand. After this there came another Serpent in, bringing in his mouth a certain herb, which he laid upon the head of the dead Serpent, whereby he restored him unto life again. *Æsculapius* using the same herb, wrought the same effect upon *Glaucus*. Whereupon (after that) *Æsculapius* (whom some affirm to be *Ophiuchus*) was placed in the Heaven, and the *Serpent* with him.

15. SAGITTA, or *Telum*; the *Arrow* or *Dart*. This was that Arrow wherewith *Hercules* slew the *Eagle* or *Grype* that fed upon the Liver of *Promotheus*, being tyed with chains to the top of the mount *Caucasus*; and in memorial of that deed, was translated into Heaven. Others will have it to be one of those Arrows which *Hercules* at his death gave unto *Philoctetes*, upon which the Destiny of *Troy* did depend. The whole Constellation containeth five Stars.

16. AQUILA, the *Eagle*, which is called *Vultur Volans*, the *flying Grype*: It hath in it 9. Stars. The Poetical reason of this Constellation, is this; *Jupiter* transforming himself into the form of an Eagle, took *Ganimides* the *Trojan Boy*, whom he greatly loved, up into Heaven, and therefore in signe thereof (because by that means he performed his purpose) he placed the figure of the Eagle in the Heaven. There belong unto this Constellation 6. Stars (before time) unformed, but now brought into the Constellation of *Antinous*. But whereupon that name should come, I know not, except it were that some man devised it there to curry favour with the Emperour *Adrian*, who loved one *Antinous Bithynicus* so well, that he builded a Temple in his honour at *Mantinea*.

17. DELPHINUS, the *Dolphin*: It containeth 10. Stars; yet

yet *Ovid* in his second Book *de Fastis*, saith that it hath but nine. Neither did the ancient Astronomers attribute unto it any more, according to the number of the Muses; because of all other Fishes, the *Dolphin* is said to be delighted with Musick. The tale goeth thus concerning this Constellation. When *Neptune* the God of the Sea greatly desired to match with *Amphitrite*, she being very modest and shame-faced, hid her self: whereupon he sent many messengers to seek her out, among whom, the *Dolphin* by his good hap, did first find her; and perswaded her also to match with *Neptune*: For which his good and trusty service, *Neptune* placed him in the Heaven.

Others say, that when *Bacchus* had transformed the Mariners that would have betrayed him, into *Dolphins*, he placed one of them in Heaven, that it might be a lesson for others to take heed how they carried any one out of his way, contrary both to his desire, and their own promise. *Novidius* referreth this Constellation unto the Fish which saved *Jonas* from drowning.

18. EQUICULUS, is the little Horse, and it consisteth of 4. Stars. This Costellation is named almost of no Writer, saving *Ptolomeus*, and *Alphonsus*, who followeth *Ptolomy*, and therefore no certain tale or History is delivered thereof, by what means it came into Heaven.

19. EQUUS ALATUS, the *Winged Horse*, or *Pegasus*, it containeth 20. Stars. This Horse was bred of the blood of *Medusa*, after that *Perseus* had cut off her head, and was afterwards taken and tamed by *Bellerophon*, whiles he drank of the River *Pirene* by *Corinth*, and was used by him in the conquest of *Chimera*: After which exploit, *Bellerophon*, being weary of the earthly affaires, endevoured to fly up into Heaven: But being amazed in his flight, by looking down to the earth, he fell from his horse; *Pegasus* notwithstanding continuing his course, (as they feigne) entred into Heaven, and there obtained a place among the other Constellations.

20. ANDROMEDA, She consisteth of 23. Stars; but one of them is common both unto her, and *Pegasus*. This was the daughter of *Cepheus* and *Cassiopeia*, and the Wife of *Perseus*: the reason why *Minerva*, or *Jupiter* placed her in the Heavens, is before expressed. *Novidius* referreth this Constellation unto *Alexandria* the *Virgin*, whom *S. George* through the good help of his horse, delivered from the *Dragon*.

21. TRIANGULUM, the *Triangle*, called also *Deltoton*, becauſe it is like the fourth letter of the Greeks Alphabet Δ, which they call *Delta*; it conſiſteth of four ſtars. They ſay it was placed in Heaven by *Mercury*, that thereby the head of the *Ram* might be the better known. Others ſay, that it was placed there in honour of the *Geometricians*, among whom, the Triangle is of no ſmall importance. Others affirme, that *Ceres* in times paſt requeſted *Jupiter* that there might be placed in Heaven ſome Figure repreſenting the form of *Sicilie*, an *Iſland* greatly beloved of *Ceres*, for the fruitfulneſſe thereof: now this Iſland being triangular, (at her requeſt) was repreſented in the Heaven under that form.

*Thus much concerning the Conſtellations of the Northern Hemiſphear. Now follow the Poeical Stories of the Conſtellations of the Southern Hemiſphear.*

## Secondly,

## *Of the* Southern Conſtellations.

1. CETUS, the *Whale*, it is alſo called the *Lion*, or *Bear* of the *Sea*. This is that monſtrous fiſh that ſhould have devoured *Andromeda*, but being overcome by *Perſeus*, was afterwards tranſlated into Heaven by *Jupiter*, as well for a token of *Perſeus* his manhood, as for the hugeneſs of the fiſh it ſelf. This conſtellation conſiſteth of 22. Stars.

2. ORION, this hath 38. Stars. The Poetical reaſon of his tranſlation into the Heaven, ſhall be ſhewn in the *Scorpion*, amongſt the Zodietical Conſtellations. The Ancient Romans called this Conſtellation *Jugala*; becauſe it is moſt peſtiferous unto Cattel, and as it were the very cut-throat of them. There are bright Stars in his girdle, which we commonly call our *Ladies yard, or wand*. *Novidius*, applying this ſword of *Orion* unto Scripture, will have it to be the ſword of *Saul*, afterwards called *Paul*, wherewith he perſecuted the Members of Chriſt: which after his converſion was placed in Heaven. In his left ſhoulder there is a very bright Star, which in Latine is called *Bellatrix*, the *Warriour*, in the fœminine gender. I cannot find the reaſon except it be this; that Women born under this Conſtellati-

on

on ſhall have mighty tongues. The reaſon of the *Ox-hide* which he hath in his hand, may be gathered out of the next ſtory.

3. FLUVIUS, the *River*; it comprehendeth 34. Stars. It is called by ſome *Eridanus*, or *Padus*; and they ſay that it was placed in Heaven in remembrance of *Phaeton*, who having ſet the whole World on fire by reaſon of miſguiding of his father *Phœbus* his chariot, was ſlain by *Jupiter* with a thunder-bolt, and tumbling down from Heaven, fell into the River *Eridanus*, or *Padus*, which the Italians call *Po*. Others ſay that it is *Nylus*, and that that Figure was placed in the Heaven becauſe of the excellency of that River, which by the Divines is called *Gihon*; and is one of the Rivers of Paradice. Others call it *Flumen Orionis*, the flood of *Orion*; and ſay, that it was placed there, to betoken the Off-ſpring from whence *Orion* came: for the tale is thus reported of him.

*Jupiter*, *Neptune*, and *Mercury*, travelling upon the earth in the likeneſs of Men, were requeſted by *Hyreus* to take a poor lodging at his Houſe for a Night: they being overtaken with the evening, yeilded unto his requeſt; *Hyreus* made them good cheer, killing an *Ox* for their better entertainment. The Gods ſeeing the good heart of the old man, willed him to demand what he would in recompence of his ſo friendly cheer. *Hyreus* and his Wife being old, requeſted the Gods to gratify them with a Son. They to fulfil his deſire, called for the hide of the Ox that was ſlain, and having received it, they put it into the Earth, and made water into it all three together, and covering it, willed *Hyreus* within ten moneths after to dig it out of the Earth again; which he did, and found therein a Man-child; whom he called *Ourion*, *ab Urina*, of piſs; although afterwards by leaving out the ſecond letter, he was named *Orion*. At ſuch time therefore as he was placed in Heaven, this flood was joyned hard to his heels, and the Ox hide wherein the Gods did piſs, was ſet in his left hand, in memorial of his Off-ſpring.

4. LEPUS, the *Hare*, which conſiſteth of 12. ſtars. This Conſtellation was placed in Heaven between the legs of *Orion*, to ſignifie the great delight in hunting which he had in his life time. But others think it was a frivolous thing, to ſay that ſo notable a fellow as *Orion* would trouble himſelf with ſo ſmal and timerous a beaſt as the *Hare*: and therefore they tell the tale thus.

In times past there was not a *Hare* left in the Isle *Leros*: a certain youth therefore of that Island, being very desirous of that kind of beast, brought with him from another Country thereabout, an *Hare* great with young; which when she had brought forth, they in time became so acceptable unto the other Countrimen, that every one almost desired to have and keep a *Hare*. By reason whereof, the number of them grew to be so great, within a short space after, that the whole Island became full of *Hares*, so that their Masters were not able to find them meat: whereupon the *Hares* breaking forth into the fields, devoured their Corn. Wherefore the inhabitants being bitten with hunger, joyned together with one consent, and (though with much ado) destroyed the *Hares*. *Jupiter* therefore placed this Constellation in the Heavens as well to express the exceeding fearfulness of the beast, as also to teach men this lesson; that there is nothing so much to be desired in this life, but that at one time or an other it bringeth with it more grief then pleasure. Some say, that it was placed in Heaven at the request of *Ganimedes*, who was greatly delighted with hunting the *Hare*.

5. CANIS MAIOR, the *Great Dog*, it consisteth of 18. Stars. It is called *Sirius Canis*, because he causeth a mighty drought by reason of his heat. This is the Constellation that giveth the name unto the *Canicular* or *Dog-days*; whose beginning and end is not alike in all places, but hath a difference according to the Country and Time: as in the Time of *Hypocrates* the Phisician, who lived before the time of Christ 400, years, the *Canicular* days began the 13. or 14. of *July*. In the time of *Avicenna*, the *Spaniard*, who lived in the year of our Lord 1100, the *Canicular* days began the 15, 16, or 17. of *July*. In our Country, they begin about S. *James-tide*, but we use to account them from the 6. of *July*, to the 17. of *August*; which is the time when the Sun beginneth to come near unto, and to depart from this Costellation.

*Novidius* will have it to be referred to *Tobias* Dog; which may very well be, because he hath a tail; *Tobias* Dog had one; as a certain fellow once concluded, because it is written that *Tobias* his Dog fawned upon his Master, therefore it is to be noted (said he) that he had a tail. The Poets say, that this is the Dog whom *Jupiter* set to keep *Europa*, after that he had stolen her away, and conveied her into *Crete*, and for his good service

was

was placed in Heaven. Others say, that it was one of *Orion* his Dogs. There belong unto this Constellation 11. Stars unformed.

6. CANIS MINOR; the *Lesser Dog*; this of the Greeks is called *Procyon*, of the Latines *Ante Canis*; it containeth but two Stars. Some say, that this also was one of *Orions* Dogs. Others rather affirm it to be *Mera*, the Dog of *Origone*, or rather of *Icarius* her father, of whom mention is made in the Constellation of *Bootes*, and *Virgo*. This Dog of meer love to his Master, being slain, as is aforesaid, threw himself into the River *Anigrus*, but was afterward translated into Heaven with *Origone*. Among the Poets there is great dissention which of the two should be the Dog of *Origone*; some saying one, and some the other, and therefore they do many times take the one for the other.

7. ARGO NAVIS, the *Ship Argo*, which comprehendeth 41. Stars; this is the Ship wherein *Jason* did fetch the Golden Fleece from *Colchis*, which was afterward placed in Heaven as a memorial, not only because of the great Voyage, but also, because (as some will have it) it was the first Ship wherein any man sayled. Their reason why this Ship is not made whole is, that thereby men might be put in mind not to despair, albeit that their Ship miscarry in some part now and then. Some avouch it to be the *Ark* of *Noe*. *Novidius* saith it is the Ship wherein the *Apostles* were, when Christ appeared unto them walking on the Sea. In one of the *Oars* of this Ship, there is a great Star, called *Canopus*, or *Canobus*, which the *Arabians* called *Shuel*, as it were a bone-fire, because of the greatness thereof. It is not seen in *Italy*, nor in any Country on this side of *Italy*. Some say that *Canobus* the Master of *Menelaus* his Ship, was transformed into this Star.

8. HYDRA, the *Hydre*; that hath 25. Stars, and two unformed.

9. CRATER, the *Cup*, or *standing piece*; that hath seven Stars. Some say that this was the cup wherein *Tagathon*, that is, the chief God, mingled the stuff whereof he made the souls of Men.

10. CORVUS, the *Crow*; this hath seven Stars. These 3. Constellations are to be joyned together, because they depend upon one History, which is this. Upon a time *Apollo* made a solemne feast to *Jupiter*, and wanting water to serve his turn, he delivered a cup to the *Crow* (the bird wherein he chiefly delighted) and sent

sent him to fetch water therein: The *Crow* flying towards the River, espyed a Fig-tree, fell in hand with the Figs, and abode there till they were ripe; In the end, when he had fed his fill of them, and had satisfied his longing, he bethought himself of his errand, and by reason of his long delay, fearing a check, he caught up a snake in his bill, brought it to *Apollo*, and told him that the snake would not let him fill the *Cup* with water. *Apollo* seeing the impudency of the bird, gave him this gift, that as long as the Figs were not ripe upon the Tree, so long he should never drink: and for a memorial of the silly excuse that he made, he placed both the *Crow*, *Cup*, and *Snake*, in Heaven.

11. CENTAURUS, the *Centaure*, which comprehendeth 37. Stars. Some say, that this is *Typhon*, others call him *Chiron*, the Schoolmaster of those three excellent men, *Hercules Achiles*, and *Æsculapius*; unto *Hercules* he read *Astronomy*, he trained up *Achilles* in Musick, and *Æsculapius* in Physick: and for his upright life he was turned into this Constellation. Yet *Virgil* calleth *Sagittarius* by the name of *Chiron*. In the hinder feet of this Constellation, those stars are set which are called the *Crosiers*, appearing to the Mariners as they sail towards the South Sea, in the form of a crosse, whereupon they have their name. The four stars which are in the Garnish of the *Centaures* Spear, are accounted by *Proclus* as a peculiar Constellation, and are called by him *Thyrsilochus*, which was a Spear compassed about with vine leaves: but they are called by *Copernicus* and *Clavius*, and other Astronomers, the stars of his Target. It should seem that they were deceived by the old translation of *Ptolome*, wherein *Scutum* is put for *Hasta*, *i.e.* the Target, for the Spear, as it is well noted by our Countryman M. *R. Record*, in his Book intituled *The Castle of knowledge*.

12. LUPUS, the *Wolf*, or the beast which the *Centaure* holdeth in his hand, containeth 19. stars; the Poetical reason is this, *Chiron* the *Centaure* being a just man, was greatly given the worship of the Gods: for which thing, that it might be notified to all posterity, they placed him by this beast, which he seemeth to stick and thrust through with his Spear, (as it were) ready to kill for sacrifice.

13. ARA, the *Alter*, it is also called *Lar*, or *Thuribulum*, *i.e.* a Chimney with the fire, or a Censor. It consisteth of seven stars, and is affirmed of some Poets, to be the *Alter* where-

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on the *Centaure* was wont to offer up his sacrifice. But others tell the tale thus, When as the great Gyants called the *Tytans*, laboured as much as might be to pull *Jupiter* out of Heaven, the Gods thought it good to lay their heads together, to advise what was best to be done: Their conclusion was, that they should all with one consent joyn hands together to keep out such fellows: and that this their league might be confirmed, and throughly ratified; they caused the *Cyclops*, (which were work-men of *Vulcan*) to make them an Altar: about this Altar all the Gods assembled, and there sware, that with one consent they would withstand their enemies; afterwards, having gotten the victory, it pleased them to place this Altar in Heaven, as a memorial of their League, and a token of that good which unity doth breed.

14. CORONA AUSTRINA, the *South Garland*, it hath 13. Stars. Some say that it is some trifling *Garland* which *Sagittarius* was wont to wear, but he cast it away from him in jest, and therefore it was placed between his legs: others call it the Wheel of *Ixion*, whereupon he was tormented for that great courtesy he would have offered unto *Juno*, thinking indeed to have gotten up her belly: but *Jupiter* seeing the impudency of the man, tumbled him out of Heaven (where by the licence of the Gods he was sometime admitted as a guest) into Hell, there to be continually tormented upon a Wheel. The Figure of which Wheel was afterwards placed in Heaven, to teach men to take heed how they be so saucie to make such courteous proffers unto other men wives. The Greeks call this Constellation by the name of *Uraniscus*, because of the Figure thereof. For it representeth the palate or roof of the mouth, which they call *Uraniscus*.

15. The last is PISCIS AUSTRINUS, or *Notius*, the *South Fish*, which comprehendeth 11. Stars besides that which is in the mouth thereof, belonging to the water, which runneth from *Aquarius*, and is called by the Arabians *Eomahant*. The reason why this *Fish* was placed in the Heaven, is uncertain: yet some affirm, that the daughter of *Venus* going into a water to wash her self, was suddenly transformed into a fish; the which fish was afterwards translated into Heaven. The unformed Stars belonging unto this Constellation are six.

*Thus much concerning the Constellations of the Northern and Southern Hemisphears; now follow the Poetical Stories of the Zodiacal Constellations.*

Thirdly

## Thirdly,

## *Of the* Zodietical Conſtellations.

1. ARIES, the *Ram*, it is called by the Greeks ♈. it containeth in it 13. Stars, which were brought unto this Conſtellation by *Thyeſtes*, the ſon of *Pelops*, and brother of *Atreus*. This is the *Ram* upon which *Phrixus*, and *Helle* his ſiſter, the children of *Athamas* did ſit, when they fled from their ſtep-mother *Ino*, over the Sea of *Helleſpont*: which *Ram* was afterward for his good ſervice, tranſlated into Heaven by *Jupiter*. Others ſay, that it was that *Ram* which brought *Bacchus* unto the ſpring of water, when through drought he was likely to have periſhed in the deſert of *Lybia*. *Ovidius* will have this to be the *Ram* which *Abraham* offered up in ſtead of his ſon *Iſaac*. The Star that is firſt in the head of the *Ram*, is that from whence our later Aſtronomers do account the Longitude of all the reſt, and it is diſtant from the head of *Aries*, in the tenth Sphear, 27. degrees 53. minutes. The unformed Stars belonging unto this Conſtellation, are five.

2. TAURUS, the *Bull*, which conſiſteth of 23. ſtars. This was tranſlated into Heaven in memorial of the rape committed by *Jupiter* on *Europa* the daughter of *Agenor*, King of Sidon; whom *Jupiter* in the likeneſs of a white Bull ſtole away, and tranſported into *Candia*. Others ſay, That it was *Io* the daughter of *Inachus*: whom *Jupiter* loved, and turned into the form of a Cow, to the intent that *Juno* comming at unawares, ſhould not perceive what a part he had playd: *Jupiter* afterward in memorial of that craftie conveyance, placed that Figure in Heaven; The reaſon why the Poets name not certainely whether it be a Cow or a Bull, is becauſe it wanteth the hinder parts; yet of the moſt of them it is called a *Bull*. In the Neck of the *Bull* there are certain ſtars ſtanding together in a cluſter, which are commonly called the *ſeven Stars*; although there can hardly be diſcerned any more then ſix. Theſe are reported to be the ſeven daughters of *Atlas*, called *Atlantiades*, whereof ſix had company with the Immortal Gods, but the ſeventh (whoſe name was *Merope*) being married unto *Siſiphus* a mortal man, did there

herefore withdraw and hide her ſelf, as being aſhamed that ſhe was not ſo fortunate in matching her ſelf as her ſiſters were. Some ſay, that that ſtar which is wanting is *Electra*, the eldeſt daughter of *Atlas*, and that therefore it is ſo dim, becauſe ſhe could not abide to behold the deſtruction of *Troy*; but at that time and ever ſince, ſhe hid her face. The reaſon why they were taken up into Heaven, was, their great pittie towards their father, whoſe miſhap they bewayled with continual tears. Others ſay, that whereas they had vowed perpetual virginity, and were in danger to loſe it, by reaſon of *Orion*, who greatly aſſayled them, being overtaken with their love; they requeſted *Jupiter* to ſtand their friend; who tranſlated them into ſtars, and placed them in that part of Heaven. The Poets call them *Pleiades*, becauſe when they riſe with the Sun, the Mariners may commit themſelves to the Sea. Others will have them to be ſo termed *a pluendo*; becauſe they procure rain. Others give them this name, of the Greek word Πλέιονες, becauſe they be many in number. They be alſo called *Vergiliæ*, becauſe they riſe with the Sun in the *Spring* time: likewiſe *Atheraiæ*, becauſe they ſtand ſo thick together. Our men call them by the name of the *ſeven Stars*, or Brood Hen. The Aſtronomers note this as a ſpecial thing concerning theſe ſtars, that when the Moon and theſe ſtars do meet together, the eyes are not to be medled withall, or cured if they be ſore: their reaſon is, becauſe they be of the nature of *Mars* and the *Moon*.

Moreover, there be five ſtars in the face of the *Bull*, repreſenting the form of the *Roman* letter V, whereof one (which is the greateſt) is called the *Bull's Ey*. They be called *Hyades*, and were alſo the daughters of *Atlas*, who ſo long bewayled the death of *Hyas* their brother, ſlain by a *Lion*, that they died for ſorrow, and were afterwards placed in Heaven for a memorial of that great love they bare to their brother. The ancient *Romans* call the *Bul's Ey*, *Parilicum*, or *Palelicium*; of *Pales* their goddeſſe; whoſe feaſt they celebrated after the conjunction of this ſtar and the Sun. The unformed ſtars belonging unto this Conſtellation, are eleven.

3. GEMINI, the *Twins*; it conſiſteth of 18. ſtars. The Poets ſay they are *Caſtor* and *Pollux*, the ſons of *Leda*, brethren moſt loving, whom therefore *Jupiter* tranſlated into Heaven. Some ſay that the one of them is *Appollo*, and the other *Hercu-*

*les*: but the moſt affirm the former. The unformed ſtars of this Conſtellation are ſeven, whereof one is called *Tropus*, becauſe it is placed next before the foot of *Caſtor*.

4. CANCER, the *Crab*, it hath 9. Stars. This is that *Crab* which bit *Hercules* by the heele as he fought with the Serpent *Hydra* in the Fen *Lerna*, and for his forward ſervice, was placed in Heaven by *Juno*, the utter enemy of *Hercules*. In this Conſtellation, there are Stars much ſpoken of by the Poets; although they be but ſmall; whereof one is called the *Crib*, other two are the two Aſſes, whereof one was the Aſſe of *Bacchus*, the other of *Vulcan*, whereon they rode to battel, when as the Gyants made war with the Gods; with whoſe braying and ſtrange noiſe, the Gyants were ſo ſcared upon the ſudden, that they forſook the field, and fled. The Gods getting the victory, in tryumphing manner tranſlated both the Aſſes, and their manger into Heaven. The unformed ſtars of this Conſtellation are four. It is called *animal retrogradum*, for when the Sun cometh into his Signe, he maketh Retrogradation.

5. LEO, the *Lyon*; it hath 27. Stars, this is that *Lyon* which *Hercules* overcame in the wood of *Nemæa* and was placed in Heaven in remembrance of ſo notable a deed. *Ovidius* ſaith, this was one of the *Lyons* which were in the den into which *Daniel* was caſt, and was therefore placed in Heaven, becauſe of all other he was moſt friendly unto *Daniel*. In the breaſt of this Conſtellation is that notable great Star, the light whereof is ſuch, as that therefore it is called by Aſtronomers Βασιλίσκος or *Regulus i.e.* the *Vicerey*, or little King among the reſt. The unformed Stars belonging to the *Lyon* are eight; whereof three make the Conſtellation which is now called *Coma Berenices*, that is, the hair of Berenice. This Conſtellation was firſt found out and invented, by *Canon* the Mathematician, but deſcribed by *Calimachus* the Poet. The occaſion of the Story was this, *Ptolomeus Evergetes* having married his ſiſter *Berenice*, was ſhortly after enforced to depart from her, by reaſon of the wars he had begun in *Aſia*: whereupon *Berenice* made this vow, that if he returned home again in ſafety, ſhe would offer up her hair in *Venus* Temple. *Ptolome* returned ſafe; and *Berenice*, according to her vow, cut off her hair and hung it up. After certain daies, the hair was not to be found; whereupon *Ptolome* the King was greatly diſpleaſed: but *Canon*, to pleaſe the humor of the King, and to curry

ry favour with him, perſwaded him that *Venus* had conveyed the hair into Heaven. *Canon* attributeth ſeven Stars unto it, but *Ptolome* allotteth it but three, becauſe the other be inſenſible.

6. VIRGO, the *Virgin*, it hath 26. Stars. This is affirmed to be Juſtice, which among all the Gods ſomtime living upon the Earth, did laſt of all forſake the ſame, becauſe of the wickedneſs that began to multiply therein, and choſe this place for her ſeat in Heaven.

Others ſay, that it was *Aſtræa*, the daughter of *Aſtræus*, one of the Gyants that were called *Titans*, who fighting againſt the Gods, *Aſtræa* took their parts againſt her own Father, and was therefore after her death commended unto the Heavens, and made one of the 12. Signes.

Others ſay, that it was *Erigone*, the daughter of *Icarius*, who for that her father was ſlain by certain drunken men, for very grief thereof did hang her ſelf: but *Jupiter* taking pitty of the *Virgin* for her natural affection, tranſlated her into Heaven.

In her right wing there is one Star of ſpecial note, which by the Aſtronomers is called *Vindemeator* (*i. e.*) the gatherer of Graps. This was *Ampelos* the ſon of a *Satyr* and a *Nymph*, and greatly beloved of *Bacchus*, unto whom in token of his love, *Bacchus* gave a ſingular fair Vine, planted at the foot of an *Elme*, (as the manner was in old time.) But *Ampelos* in Harveſt gathering Graps, and taking little heed to his footing, fell down out of the Vine, and brake his neck. *Bacchus* in memorial of his former affection, tranſlated him into Heaven, and made him one of the principal Stars in this Conſtellation. There is another great Star in the hand of the *Virgin*, called of the Latines *Spica*, of the Greeks *Stachus*, of the Arabians *Azimech* (*i. e.*) the *Ear of Corn*: whereby they ſignify, that when the Sun cometh to this Signe, the Corn waxeth ripe. *Albumazar* the Arabian, and *Novidius*, take this Conſtellation for the Virgin *Mary*. The unformed Stars in this Conſtellation, are ſix.

7. LIBRA, the *Ballance*, it containeth 8. Stars. *Cicero* calleth it *Jugum* the *Yoak*, and here it is to be noted, that the Ancient Aſtronomers that firſt ſet down the number of the Conſtellations contained in the Zodiack, did account but eleven therein, ſo that the Signe which now is called *Libra*, was heretofore called Χηλαὶ, that is to ſay, the *Claws of the Scorpion*, which poſſeſſeth the ſpace of two whole Signes. But the latter Aſtronomers, being de-

ſirous to have 12. Signes in the Zodiack, called thoſe eight whereof the *Claws of the Scorpion* do conſiſt, by the name of *Libra*; not that there was any Poetical Fiction to induce them thereto, but only moved by this reaſon, becauſe the Sun joyning with this Conſtellation, the Day and the Night are of an equal length, and are (as it were) equally poyzed in a pair of Ballance. Yet (as I remember) ſome will have this to be the Ballance wherein Juſtice, called alſo *Aſtræa*, weighed the deeds of mortal men, and therein preſented them unto *Jupiter*. It hath 9. unformed Stars appertaining unto it.

8. SCORPIO, the *Scorpion*; called of the Arabians, *Alatrab*; of *Cicero*, *Nepa*. It conſiſteth of 21. Stars. The Fiction is thus. *Orion* the ſon of *Hyreus* greatly beloved of *Diana*, was wont to make his boaſt, that he was able to overcome what beaſt ſoever was bred upon the Earth: The Earth being moved with this ſpeech brought forth the *Scorpion*, whereby *Orion* was ſtung to death. *Jupiter* thereupon (at the requeſt of the Earth,) tranſlated both the *Scorpion*, and *Orion* into Heaven; to make it a leſſon for ever for mortal men, not to truſt too much unto their own ſtrength. and to the end he might ſignify the great enmity between them, he placed them ſo in the Heaven, that whenſoever the one ariſeth, the other ſetteth; and they are never both of them ſeen together above the Horizon at once. *Gulielmus Poſtellus* will have it to be the *Serpent* which beguiled *Eve* in Paradiſe. The unformed Stars about this *Scorpion* are three.

9. SAGITTARIUS, the *Archer*. It hath thirty one Stars. Touching this Signe, there are among the Poets many and ſundry opinions. Some ſay that it is *Crocus*, the ſon of *Pupheus*, that was nurſe unto the Muſes. This *Crocus* was ſo forward in learning of the liberal ſciences, and in the practiſe of feats of activity, that the Muſes entreated *Jupiter* that he might have a place in Heaven. To whoſe requeſt *Jupiter* inclining, made him one of the 12. Signes: And to the end that he might expreſs the excellent qualities of the Man, he made his hinder parts like unto a Horſe, thereby to ſignify his ſingular knowledge in Horſe-manſhip: and by his Bow and Arrow, he declared the ſharpneſs of his Wit. Whereupon the Aſtrologers have this conceit, that he that is born under *Sagittarius*, ſhall attain to the knowledge of many Arts, and be of prompt wit, and great courage. *Virgil* affirmeth this to be *Chiron* the Centaur, who for his ſingular learning and Juſtice,

was

was made the Master of *Achilles*. At which time *Hercules* coming to visit him (for he had heard both of the worthiness of the School-master, and of the great hopes of the Scholler) brought with him his quiver of Arrows dipped in the blood of the Serpent *Hydra*; but *Chiron* being desirous to see his shafts, and not taking heed of them, being in his hand, let one of them fall upon his foot, and being greatly tormented, not only by the anguish of the poyson working in the wound, but much more because he knew himself to be immortal, and his wound not to be recovered by medicine, he was enforced to make request unto the Gods, that he might be taken out of the World, who pitying his case, took him up into Heaven, and made him one of the 12. Signes.

10. CAPRICORNUS, the *Goat*, it consisteth of 28. Stars. The Poets say, that this was *Pan*, the God of the Shepherds, of whom they faign in this manner: The Gods having war with the Gyants, gathered themselves together into *Ægypt*, *Typhon* the Gyant pursued them thither, whereby the Gods were brought into a quandary, that well was he that by changing his shape might shift for himself. *Jupiter* turned himself into a *Ram*: *Apollo* became a *Crow*: *Bacchus*, a *Goat*: *Diana* lurked under the form of a *Cat*: *Juno* transformed her self into a *Cow*: *Venus* into a *Fish*: *Pan* leaping into the River *Nilus*, turned the upper part of his body into a *Goat*, and the lower part into a *Fish*. *Jupiter* wondring at his strange device, would needs have that Image and Picture translated into Heaven, and made one of the 12. Signes. In that the hinder part of this Signe is like a Fish, it betokeneth that the latter part of the moneth wherein the Sun possesseth this Signe, inclineth unto Rain.

11. AQUARIUS, the *Waterman*. It hath 42. Stars, whereof some make the Figure of the Man: other some the Waterpot; and some, the stream of water that runneth out of the pot. This is feigned to be *Ganimedes* the *Trojan*, the son of *Oros*, and *Callirhoe* whom *Jupiter* did greatly love for his excellent favour and beauty, and by the service of his Eagle carried him up into Heaven, where he made him his Cup bearer, and called him *Aquarius*. Others notwithstanding thinke it to be *Deucalion* the son of *Prometheus* whom the Gods translated into Heaven, in remembrance of that mighty deluge which happned in his time, whereby mankind was almost utterly taken away from the face of the earth. The unformed stars belonging unto this Signe are three.

12. PISCES, the *Fishes:* these, together with the line that knitteth them together, contain 24. Stars. The Poets say that *Venus* and *Cupid* her son coming upon a certain time unto the River *Euphrates*, and sitting upon the bank thereof, upon a sudden espied *Typhon* the *Gyant*, that mighty and fearfull enemy of the Gods coming towards them; Upon whose sight, they being stricken with exceeding fear, lept into the River, where they were received by two Fishes, and by them saved from drowning. *Venus* for this good turn, translated them into Heaven. *Gulielmus Postellus* would have them to be the two Fishes wherewith Christ fed the 5000. men. The unformed stars of this Constellation, are four.

Thus have I breifly run over the Poetical reasons of the Constellations: It remains now that I speak of the *Milky way*.

VIA LACTEA, or *Circulus Lacteus*; by the Latines so called; and by the Greekes *Galaxia*; and by the English, the *Milkey way*. It is a broad white Circle that is seen in the Heaven, in the North Hemisphere, it beginneth at *Cancer*, on each side the head thereof, and passeth by *Auriga*, by *Perseus*, and *Cassiopeia*, the *Swan*; and the head of *Capricorn*, the tayl of *Scorpio*, and the feet of *Centaur*, *Argo* the *Ship*, and so unto the head of *Cancer*. Some in a sporting manner do call it *Watling street*; but why they call it so, I cannot tell; except it be in regard of the narrowneſſe that it seemeth to have; or else in respect of that great high way that lieth between *Dover* and *S. Albons*, which is called by our men, *Watling street*.

*Ovid* saith, that it is the great Causey, and the high way that leadeth unto the Pallace of *Jupiter*; but he alledgeth not the cause of the whiteness: belike he would have us imagine that it is made of white Marble.

Others therefore alledge these causes: *Jupiter* having begotten *Mercury* of *Maia* the daughter of *Atlas*, brought the child when he was born, to the breast of *Juno* lying a sleepe: But *Juno* awaking threw the child out of her lap, and let the milke run out of her breast in such aboundance that (spreading it self about the Heaven) it made that Circle which we see. Others say, that it was not *Mercury*, but *Hercules*; and that *Juno* did not let the milke run out of her breast; but that *Hercules* suckt them so earnestly, that his mouth run over, and so this Circle was made.

Others say, that *Saturn* being desirous to devour his children,

his

his wife *Ops* presented him with a stone wrapped in a clout, instead of his child: This stone stuck so fast in *Saturn* his throat as he would have swallowed it, that without doubt he had therewithall been choaked, had he not been relived by his wife, who by pressing the milke out of her breasts saved his life: the milke that missed his mouth (whereof you must suppose some sufficient quantity) fell on the Heavens, and running along made this Circle.

Dr. Hood *Commenting upon Constellations, saith;* The Stars are brought into Constellations, for Instruction sake, things cannot be taught without names: to give a name to every Star had been troublesome to the Master and for the Scholler; for the Master to devise, and for the Scholler to remember: and therefore the Astronomers have reduced many Stars into one Constellation, that thereby they may tell the better where to seek them; and being sought, how to express them. Now the Astronomers did bring them into these Figures, and not into other, being moved thereto by these three reasons: first these Figures express some properties of the Stars that are in them; as those of the *Ram* to to be hot and dry; *Andromeda* chained betokeneth imprisonment, the head of *Medusa* cut off signifieth the loss of that part: *Orion* with his terrible and threatning gesture, importeth tempest and terrible effects: The *Serpent*, the *Scorpion*, and the *Dragon*, signify poyson: The *Bull* insinuateth a melancholy passion: The *Bear* inferreth cruelty, &c. Secondly, the Stars, (if not precisely, yet after a sort) do represent such a Figure, and therefore that Figure was assigned them: as for example, the *Crown*, both North and South; the *Scorpion*, and the Triangle, represent the Figures which they have. The third cause was the continuance of the memory of some notable men, who either in regard of their singular pains taken in Astronomy, or in regard of some other notable deed, had well deserved of Man-kind.

The first author of every particular Constellation is uncertain; yet are they of great antiquity; we receive them from *Ptolomie*, and he followed the *Platonicks*; so that their antiquity is great. Moreover we may perceive them to be ancient by the Scriptures, and by the Poets. In the 38. Chapter of *Job* there is mention made of the *Pleiades*, *Orion*, and *Auctarus*, and *Mazzaroth*, which some interpret the 12. Signes: *Job* lived in the time of *Abraham*, as *Syderocrates* maketh mention in his Book *de Commensurandis locorum distantiis*.

Now

Now beſides all this, touching the reaſon of the invention of theſe Conſtellations, the Poets in ſetting forth thoſe Stories, had this purpoſe, to make men fall in love with Aſtronomy. When *Demoſthenes* could not get the people of *Athens* to hear him in a matter of great moment, and profitable for their Common-wealth, he began to tell them a tale of a fellow that ſold an Aſs; by the which tale he ſo brought on the Athenians, that they were both willing to hear his whole Oration, and to put in practice that whereunto he exhorted them. The like intent had the Poets in theſe Stories: They ſaw that Aſtronomy being for commodity ſingular in the life of man, was almoſt of all men utterly neglected. Hereupon they began to ſet forth that Art under theſe Fictions; that thereby ſuch as could not be perſwaded by commodity, might by the Pleaſure be induced to take a view of theſe matters, and thereby at length fall in love them. For commonly note this, that he that is ready to read the Stories, cannot content himſelfe therewith, but deſireth alſo to know the Conſtellation, or at leaſtwiſe ſome principal Star therein.

*FINIS.*

# A Diſcourſe OF THE *Antiquity, Progreſs,* AND *Augmentation* OF ASTRONOMIE.

Artic. I. *Obſervation Celeſtial, from the beginning of the world; though rude and in-artificial.*

FIRST it ſeems not to be doubted, but that there was ſome kind of obſervation of Bodies Cœleſtial, as ſoon as there were Men: conſidering that the ſpectacle which the Heavens conſtantly preſent, is both ſo glorious, and ſo uſefull, that men could not have eyes to ſee, and not fix them attentively and conſiderately thereupon. For, among other Apparences, when they ſaw the Sun dayly to change the places of its riſing and ſetting; at certain times of the Year: to approach neerer to the Earth in its Diurnal arch, and at others again to mount up to a height much more ſublime and remote from it: and that his coming neerer to the Earth made *Winter*, and his remove higher made *Summer*: we ſay, when they beheld theſe things; doubtleſs,

less, they could not but seriously remark and consider this vicissitude, according to which they might expect the Season would be more hard, or mild, to them in this lower Region of the World. Again, so admirably various did the Moon appear, in her several shapes and dresses of light, that she could not but invite mens eyes, and engage them to frequent Speculations: specially when she assumed those various faces or apparences, at set and certain Times; in respect whereof it came to pass, that every Nation measured their times and Seasons, by those her constant and periodical circuits; and this, because those periods succeded much more frequently, than the Erections and Depressions of the Sun. To these, we may add that beautifull shew of the Nightly Stars, undergoing likewise their Variations, according the variety of Seasons; and more particularly that bright star of *Lucifer*, rising sometimes later, sometimes earlier, and sometimes not at all before the Sun, and the like. But, what we shall principally note, is only this; that though Mankind was long, before they came to make inquiries into the Causes of these Cœlestial changes and variations, restrained to set periods: yet they observed them from the very first Age, and not only admired, but also accommodated what they observed, to the uses of their Lives and their Successors. Here it might not be fruitless, to remember, that PROMETHEUS, who was imagined to have framed the first Man, was also imagined to have given him an erected Figure, and sublime Countenance; to the end he might the more advantageously advance his eyes to the Heavens, and contemplate the glory and motions of the Cœlestial Lights. But, because this is too General, and rude a way of observation; and it is our business to look back into those times *wherein men first made such Observations of Sydereal bodies, as gave them the hint and occasion of reducing them to Method, and founding the principles of the Art, or Science of Astronomy, thereupon:* we must have recourse to the monuments in *Sacred Writ*, for the understanding of that obscure matter.

Articl. II. *Sacred records examined, and* Moses *found to be the First* Astronomer *there spoken of.*

And indeed, the light we expect from *Sacred Leaves*, would soon be clear enough to discuss all the darkness, wherein the Original of Astronomy seems involved; could we but from them deduce the least evidence for that which the learned Antiquarie among the Jewes, *Josephus* affirms of the Sons of *Seth*; *viz. that they invented the science of the Heavens, before the Flood,*

*and*

*and engraved the ſame on two Pillars, the one of Brick, the other of Stone, that ſo it might be preſerved in the one, in caſe the fury of the Deluge to come, ſhould demoliſh and deface the other:* or if there remained to us any the moſt ſlender teſtimony of the Reaſon he there gives, of the ſo great Longevity of men in thoſe dayes; namely, that the duration of their lives was ſufficiently long, to perfect the knowledge of Aſtronomy, which requires full 600 Years, at the leaſt, to the obſervation of all the Varieties of Cœleſtial motions: Whereupon He notes, that the Great Year (as they call it) doth conſiſt of ſix hundred common Years; the vulgar opinion being, that the Celeſtial Motions do continually vary, lib. 1. Ant. c. 3. cap. 4.

*Donec conſumpto, Magnus qui dicitur, Anno,*
*Rurſus in antiquum redeant vaga ſidera curſum,*
*Qualia præteriti ſteterant ab origine mundi.*

*Epigram. de ætat. Anim.*

Again, the buſineſs might be deduced from not long after the Flood, if in Scripture we could find but the leaſt word from whence might be argued the truth of what the ſame Author writes; namely, that the *Egyptians were taught Aſtronomy, by Abraham.* Probable enough it is, we confeſs, that *Beroſus*, and others, quoted aſwell by *Joſephus*, as *Euſebius*, had read ſome ſuch thing in ſome Books of the old Rabbins: but that the ſame ſhould be fetched from Holy Writ, is moſt improbable, therein being no mention at all of any ſuch thing. Beſides, there are pious and learned Doctors, and among them *Salianus*, who will not allow it to be ſo much as probable, that *Abraham* ſhould inſtruct the Egyptians in Aſtronomy: becauſe of the very ſmal time of his ſtay among them in Egypt. It is written indeed, that *Abraham came from Ur of the Chaldeans:* but not that he received Aſtronomy from the Chaldeans, or that he delivered it from them to the Egyptians. And therefore they conclude, that what *Joſephus* ſaid of *Abrahams* reading Aſtronomy in Egypt, may with more probability be imputed to his Great-grand child, *Joſeph.* Concerning Him, therefore, we read (in truth) that he was ſingularly favourable to the Prieſts in Egypt, at ſuch time, as all the reſt of the people mortgaged their lands to the King, for bread, during that wofull and long Famine. For, He except- *Gen.* 11.

ted the Lands belonging to the Prieſthood, and (as the Text
*Gen.* 47. ſaith) aſſigned them certain portions out of the publick Granaries; ſo that from hence may be proved (what *Ariſtotel* tells
*1. Polit. cap.* us, from other Authority) that amongſt the Egyptians, the moſt
*and 1 Metaph.* ancient Nation, the Prieſts were exempted from labour, and left to
*cap. 1.* the eaſy imploiment of their minds: and that this gave them occaſion to invent and conſtitute the Mathematiques: and yet for all this, it is not written, either that *Joſeph* taught thoſe Egyptian Prieſts the Mathematiques, or that they taught them to him. And, perhaps that Favour He ſhewed the Prieſts, was an argument not only of the Reſpect and Veneration, born them by the King and all his people; but alſo of his particular Gratitude toward them; in that He, who had been bred up only to Sheppardry and Country imployments, and was wholy ignorant of all Arts and Sciences, at his firſt comming among them being afterwards advanced to the height of a Courtier, and luſtre of a Favorite, had bin inſtructed by them in ſomething more noble and ſublime. And truely, the Divine *Moſes*, not long after admitted into the ſame Court, is not delivered ſo much to have erudited any others, as
*Act.* 7 to have been himſelf *learned in all the Wiſdom of the Egyptians.* Nevertheleſs, conſidering that this Wiſedom of the Egyptians, doubtleſs contained the Mathematiques; and that Aſtronomy was ever eſteemed the beſt and nobleſt part of them: this Erudition of *Moſes* ſeems to be the moſt Ancient monument of the Science of the Stars, that can be found in Holy Writ.

Aſtronomy, you ſee, is of great Antiquity, even upon the Records of Divinity; and might be proved of much greater, could we but evince (what ſome alleage) that the Hiſtory of *Job* was penn'd by *Moſes*, as living a good while after him.
*Cap.* 9. Becauſe *Job* there mentions *Arcturus*, *Orion*, and the *Hyades*, or watery Conſtellation: and therefore it muſt be, that before that time the Stars had been ranged and diſpoſſed into certain Aſteriſms, according to ſome certain method or artificial Theory then in uſe. But, be the time of his life never ſo uncertain, yet we may certainly obſerve from the Hiſtory thereof; that it ſeems *Job*, being an Alien to the Hebrews, derived his knowledge of God from that which in Scripture is called, *Cœlorum Exercitus*, the *Hoſt of Heaven*. Foraſmuch, as the Inviſible things of God are not ſo well learned from any viſible things of Nature, or the effects of his Wiſedom and Power, as from the Cœleſtial

Orders

Orders and therefore *Synesius* justly calling Astronomy [σεμνὸν ἐπιστήμην] *a truly-venerable Science*; he saith, that it advanceth the mind to something of greater both Antiquity and Nobility, *viz.* ineffable Theology. That we may be breef, and only touch upon that sentence in the Book of Wisedom that God gave to *Solomon*, among other of Natural Science, to *understand the Course of the Year and the Dispositions of the Stars*: if any thing in Sacred Writ doth expressly prove the Antiquity of Observations Astronomical, and the founding or erecting any setled Art thereupon; it must be that, of which the Holy Prophets complaind in their dayes; *viz.* that there were Chaldæans, who at *Babylon, did contemplate the Stars, and compute the Months, that from them they might foretell things to come.* For, from hence we understand, that the observation of the Motions of Heavenly bodies was a certain profest Art; and of great Antiquity, among the Chaldeans.

*de dono ad Pæon.*

*cap.* 7.

*Esa.* 47.

In the *Second* place, we are to revolve the Records of *Ethnick Authors*, to see if among them we can find the time of the Nativity of Astronomy.

Article, 3. *Ethnick monuments likewise revolved; and first those of Fabulous times: according to which Cœlus is found the most ancient Astronomer;* *lib.* 3.

Look we therefore back, first, into the remains of that part of Time, which is called *Obscure*, or *Fabulous*; because possibly enough something of truth, concerning our enquiry, may be found wrapt up in the darksome shrouds of Fables. And begin we at the most ancient of Heathen Gods, *Cœlus*, in Greek Οὐρανὸς who, as *Diodorus Siculus* delivers, was so named, because of his high devotion to, and delight in the observation of the Stars. This eminent person being the Father of many Sons as *Atlas*, *Saturnus*, the *Titanes*, and among those especially *Hyperion* and *Japetus*; it is lawfull for us to conjecture, that led by his example, his whole family were addicted to the same Study. For seeing that *Cœlus* lived in *Mauritania*, not far from the Ocean; and thence extended his Kingdom not only over all *Africa*, but also into a considerable part of *Europe*: it is well known that his Son *Atlas*, who succeded him in the same Dominions, is allowed to have given his name to the highest Mountain of that Country; only because he had made his observations of the motions of the Heavens and Stars, from the top thereof. For, the Ancients in those dayes, as the vulgar now in ours, imagined the arch of the Heavens to be so little distant from the tops of great Mountains; as that by how much

*and after him his Sonns.*

1. Atlas, *who taught Astronomy to his Son.*

much the higher any man ascended on those hills, by so much the more clearly and distinctly might he behold Cœlestial objects. To this, *Diodorus*, *Plinie*, and others add; that *Atlas* was feigned to support Heaven on his Shoulders, only because He had framed a Sphear, wherein the whole Heavenly machine was strongly represented: and *Clemens Alexandrinus* observes, that *Hercules*, being both *Vates and Physicus*, a Prophet and Philosopher, was reported to come and relieve *Atlas* (his great Uncle) by taking the vast Burden of Heaven upon his own Shoulders; because He succeded him in that difficult task the Study, or science of Cœlestial bodies. Of *Hesperus*, the Sonne of *Atlas*, it is recorded, that while he was busy in speculating the Stars, on the top of the same mountain, he was snatched away by the violence of some disease, and could never be found: and that thereupon, the common people, in respect of his piety and justice, gave his name to the most beautifull and resplendent Star, which is also called *Vesperugo*, being *Venus*, while she is in the *West*. As for his Sisters, called both *Atlantiades*, and *Pleiades*; these likewise gave their name to that glomération of Stars, which are visible in the back of *Taurus*: and of one of them, named *Maia*, was born the *Famous Mercurius*, said to have brought the Science of the Stars first into *Egypt*. Whence *Marcilius*, writing of the Astronomy of the *Egyptians*, Saies of *Mercury*

*lib.* 3.
*lib.* 2. *cap.* 8.
*Astrom.* 1.
Hisperus.
And Daughters, the Atlantides and Pleiades, from one of whom came Mercury.
1. Astron.

*Tu Princeps, Author q;, sacri, Cyllenie, tanti. &c.*

Though we well know, that the *Ethiopians*, allowing the *Egyptians* to be no other, but one of their *Colonies*, sent abroad to find room to subsist in, contend; that they recieved *Astronomy* from them: as first *Diodorus*, and after *Lucian* have observed. Here it is well worthy our commemoration, what *Cicero* saith, as of *Atlas* and *Prometheus*, so also *Cepheus*, a King of "the *Ethiopians*: *viz.* Neither had *Atlas* been beleived to "have sustain'd Heaven, nor *Prometheus* to have been chain'd on "*Caucasus*: nor *Cepheus* with his Wife, Son-in Law, and Daugh-"ter, to have been Stellified: had not their Divine cognition "of Cœlestial bodies first occasioned the perpetuation of their "Names in the disguise of Fables.

*lib.* 3.
*lib. de Astrol.*
5. *Tusculan.*

To-

To return to *Saturn*, another *Sonne* of *Cœlus*; He, leaving *Africa*, and reigning only in *Italy*, *Sicily* and *Crete*; may be thought to have prosecuted his Fathers studies, no less than the former: and we have this argument for it, that the Slowest of all the Planets bears his name, to this very Day; probably, bacause he was the first, who understood the motion and course of that Planet, which was by the *Greeks* called Κρόνος from χρόνος Time, foralmuch as of all the Cœlestial Circuits none was found so diuturn. And of his Sons, since *Pluto* addicted himself intierly to Husbandry, *Neptune* to Navigation; we may conceive, that *Jupiter*, applying his mind to nobler cares, succeded his Father in the Study of the Heavens: as also that he chose *Olympus*, accounted the highest mountain, to make his observations upon: so that in process of time, he came therefore to be called *Olympius*; and the name of that mountain to be transferred upon Heaven it self; whose orders and laws He well understanding, was thereupon said to have the Dominion of Heaven. Certain it is, that the *Grecians* ascribed the Original of this noblest Science, partly to the *Gods* themselves, and partly to ancient *Hero's*: which *Achilles Tatius* seasonably alluding unto, introduceth old *Æschylus* attributing to God, that He shewed the risings and settings of the Stars, and distinguish't Winter, Summer, and the other Seasons; and *Ovid* Fathers the same wholly upon *Jupiter*.

2. Saturn, *who delivered the same to his Son.*

Jupiter.

*Isagog. ad Phœn.*

*Pergè Hiemes, Æstusqs, & inæquales Autumnos,*
*Et breve Ver, spatijs exegit quatuor Annum.* 1. *Metamorph.*

Besides, it is in the Fiction, that *Jupiter* took his Father, *Saturn*, bound him, and precipitated him into Hell. Now this seems to intimate, that *Jupiter* having imposed his own name upon one of the most eminent and illustrious of the Planets, gave that of his Father to another of them, that was more remote, situate in the deepest part of the Ætherial spaces, and of the slowest progress: though all this while we are not ignorant, that those names were fixed upon those *Planets* a long time after: since more anciently the *Planet Jupiter* was called *Phaeton*, and that of *Saturn*, *Phœnon*. For, we may collect very neer as much from *Lucian*, who by *Tartarus* understands the immense Altitude

tude, or Profunditie of the Ætherial Region: & ſo denies that *Saturn* was either exil'd by *Jupiter* into Hell, or caſt into bonds; as common heads were perſwaded to beleeve.

3. Hyperion.

As for *Hyperion*; *Diodorus* hath a tradition, that he being of the progeny of old *Cœlus*, demonſtrated the courſes of the Sun and Moon: and therefore called the Sun, *Helios*, after the name of his Sonne; and the Moon, *Selene*, after that of his Daughter.

4. Japetus: *from whom came* Prometheus, *who followed the ſame ſtudy.* *in Eccleſ.* 7.

Laſt of all comes *Japetus*, who alſo was the Sonne of *Cœlus*, but performed nothing worthy commendation in the advance of his Fathers Speculations: but *Promotheus*, whom he begat, was therefore imagined to have been chained on the hill *Caucaſus*, and to have his heart perpetually torn by a hungry Eagle or Vultur; Becauſe (as *Servius* expounds the riddle) with reſtleſs care, and ſolicitude of mind, he conſtantly excruciated himſelf with obſerving the Stars, and ſtudying their Aſcenſions and Declinations. We ſhall not inſiſt upon what follows in the ſame Author, namely that this *Prometheus* was the firſt, who introduced *Aſtrology* to the *Aſſyrians* (not far from *Caucaſus*:) it being more uſefull for us now to obſerve, that He was imagined to have ſtolen Fire from Heaven, for the inanimation of Man, for no other reaſon, but becauſe he infuſed this Heaven-fetch't Knowledge into the breaſts of men, and inflamed their ſouls with the deſire and love thereof. For, as to the remainder; for as much as *Belus* was the ſame with *Jupiter*, among the *Aſſyrians*, as *Diodorus* teſtifies: it is He rather, who was accounted both the moſt ſacred of their Dieties, and the Inventor of this Sideral Science; as *Pliny* affirms.

*lib.* 2. *fol.* 37. *c.* 10.

*ſo did* Phaeton,

It is not needfull for us here to examine many other of the ancient Traditions, accounted likewiſe among the Fabulous; as, in particular, the Fable of *Phaeton*, which hath this Mythology, that in his life time he had made a conſiderable progreſs toward the diſcovery of the Suns Anntual courſe; but dying immaturely, he left the Theory thereof imperfect. That other of *Bellerophon*, whom Interpreters maintain to have been carried up to Heaven, not by a flying horſe, but a ſtudious and contemplative mind, eager in the queſt of Syderal myſteries. That of *Dædalus*, who indeed, by ths ſame towring ſpeculations, as by the artifice of wings, mounted up to the Northern part of Heaven; while his leſs ingenious Sonne, *Icarus*, falling ſhort in his attempt of imitating his Fa-

Dædalus, *Icarus*,

thers

thers sublime flight (as not so well understanding the demonstrations of the reasons of his Theory) flaggd very low in his Studies: and fell from the true and apodicticall cognition of Cœlestial motions and vicissitudes: with many other the like, recounted by *Lucian*; as that of *Endymion*, the favourite of the Moon; of *Tiresias*, the Prophet, &c. Yet one thing there is, mentioned as well by *Lucian*, as *Tatius*; which we cannot well pass by; which falling under the account of Heroicall times, seems to come somwhat neer to that which is called Historicall. And that is the notable Contention that arose betwixt *Atreus* and *Thyestes* about supreme dominion. For when by the publike Consent and Vote of the *Argives*, the Kingdom was to be his of the two, who should give the most eminent testimony of Science: it came to *Atreus* share to be King: because, though *Thyestes* shewed them the signe *Aries*, in Heaven (for which he was honourd with a golden Ram) yet had *Atreus* declared a thing more excellent: while discourfing about the variety of the Suns rising, he made it appear, that the Sun and the World (*i.e.* the Starry Orb) were not carryed the same, but quite contrary wayes; and consequently, that that part of the Heavens which was the *West* or *Occident* of the Starry Orb, was the very rising, or *Orient* of the Solary. Hence that verse of *Euripides*,

*de Astrol. in Isagog.*

Atreus *and* Thyestes.

Δείξας γὰρ ἄστρων τὴν ἐναντίαν ὁδὸν
*Qui Astrorum enim contrariam ostendit viam.*

To the same times likewise are we to refer the *Institution of the Olympick Games, by Hercules*; which after a long interruption were renewed by *Iphitus*. For, inasmuch as those sports were instituted for no other end (as may be assured from *Censorius*) but that their celebration might put men in mind of that *Intercalation* of a month and half, that was to be made constantly every fourth Year, in respect of those four times eleven, or 44. Dayes, by which the motion of the Moon anticipated that of the Sun; and the four times six hours, or one whole Day, by which the circuit of the Sun exceded 365 Dayes: manifest it is, that *Hercules* could not understand this, without having first exactly observed the Motions of Sun and Moon. Hither also belongs that which is reported of *Orpheus*, who must needs have attentively observed the seven *Planets*, if it be true, as

Hercules *and* Iphitus. *cap.* 18.

Orpheus.

*de Astrol.* *Lucian* averrs, that he represented their Harmony by his *Seven-stringed Harp*: which the *Grecians* thereupon designed in Heaven, by some Stars, that to this Day retain the name of *Lyra*. So likewise doth what *Sophocles* saith of *Palamedes*, who pointed out the several Asterisms, and particularly

Palamedes.

Ἄρκτου Στροφάς τ', καὶ κυνὸς ψυχρὰν δύσιν
*Vrsum volutam, gelidum & occasum Canis.*

Homer. And lastly, what *Homer* recounts, that in those times were well known (besides *Bootes* and the *Bear*, or *Wain*)

*Odyss. E.*

Πληϊάδας, θ' Ὑάδας τ', τὸ σθένος Ὠρίωνος.
*Pleiades, atq; Hyades, roburq; ipsum Orionis.*

Articl. 4. We have now struggled through the Darkness of Fabulous Times, and are advanced as far as to discerne the twilight of *Historicall*. An here, the first thing we clearly perceive, is that the *whole Controversy about the Antiquity of Astronomical Observations, lies betwixt the Egyptians and the Assirians, or Babylonians*. For, as to the *Grecians*, though some have thought they might put in also for a claim to the honour of being the Anthors of this admirable Science; yet by the Verdict even of *Plato* himself, they are to lay by the pretence of Competition, "For, sayth He, the first who made Syderal inspections, was a "*Barbarian*; a more ancient Nation than ours bred those men, "who first devoted their minds to that Study, in respect of the "Summer-like serenity and perspicuity of the Air, such as *Egypt* "enjoyes, and *Syria*, where all the Stars are, clearly visible, and "no Clouds or Mists to obscure the beautifull face of Heaven. And certainly, if we except what we newly mentioned, the Institution of the *Olympick Games* by *Hercules*, and the restauration of them after some Intermission, by *Iphytus*, which hapned about 800. Years before Christ; and some places in the writings of *Homer*, and more especially of *Hesiod*, who lived neer upon the same time, or not long before; we shall find that the *Grecians* can produce no Monuments of their Observations of the Heavens, more ancient than those of *Thales*, who flourisht, full 600. Years before Christ; and who yet borrowed his knowledge of Ætherial

*Secondly, those* Historical *times; according to which, the antiquity of Astron. Observations belongs either to the* Egyptians, *or* Babylonians. *in Epinom.*

Ætherial Matters from *Egypt*. It being manifeſt therefore, that the *Ægyptians*, or their Prieſts, are the only men, that ought to be admitted to a Diſpute with the *Aſſirians* or *Babylonians*, or their Philoſophers, concerning the Antiquity of Obſervations; and that their ſeveral Pleas ſeem equally reaſonable. Truly, it is no eaſy matter to determine the difference, ſo as to place the Lawrell on their heads to whom it doth of right belong. For, albeit *Joſephus* aſſignes the Honour to the *Chaldæans*, and others again ſtand firmely for the *Egyptians*: yet *Plato*, *Diodorus*, *Lucian*, *Achilles Tatius*, and others alleadge ſuch quotations for each party, as ſeem to have no other, but the authority of the parties themſelves. Nor ought that to ſeem ſtrange; ſince both ſides equally alleadge the convenience of their vaſt Companies, and the ſerenity of the ſky; ſince they both boaſt themſelves the Original Nation, and allow their Competitors to be only *Colonies*; ſince both glory in fabulous beginnings, which we cannot trace or diſcuſſe; and both recur to egregious falſhoods about the time when their Anceſtors firſt made Cœleſtiall Scrutenies. For, the *Chaldæans* (as we find on the Regiſter of *Diodorus*) affirm, that their Nation applied themſelves to theſe Studies, from times of incredible Antiquity, *viz.* of four hundred and three thouſand Years: And the *Egyptians* (as *Cicero* obſerves) talk of Obſervations of four hundred thouſand and ſeventy Years ſtanding. Unleſs you ſhall pleaſe to conſigne the Victory to the *Egyptians*, becauſe they put a value only themſelves by Auction. As if it were not enough for them to boaſt thoſe four hundred nine thouſand Years (mentioned by *Laertius*) in which from the time of *Vulcan*, the Sonne of *Nilus*, to that of *Alexander* of *Macedon*, there hapned of *Eclipſes* of the Sun three hundred ſeventy three, and of the Moon eight hundred thirty two. Theſe conſiderations premiſed, we cannot indeed deny, but the *Egyptians* had ſome Obſervations, ſome ages before *Thales* and other *Grecians* travelled among them: but, when we would enquire more preciſely into the time, when thoſe Obſervations firſt begun; we find our ſelves at a loſs, and brought back again into the cimmerian obſurity of Fabulous Times.

1. *Antiq.* 8. *in Epinom.* 2. *lib. de Aſtrolog. Iſagog.*

*loc. citat.*

*de Divinat.*

*in præfat.*

Now foraſmuſch as, though *Pliny* writes, that *Epigenes* found no Obſervations among the *Babylonians* of above ſeven hundred and twenty Years antiquity, and thoſe engraven on artificial Tyles or Slates; and the moſt ancient *Eclipſes* deduced from them, were

*lib. 9. c. 55.*

*in Almageſt. lib. 4. cap 6.*

tranſmitted to *Ptolomy*, about the ſame Number of Years before Chriſt: and that by the great *Hipparchus*. And to the ſame Time belongs what *Beroſus* and *Critodemus* ſay, that in their Dayes, there were extant no Obſervations of more than four hundred and thirty Years as may be found alſo in *Pliny*: foraſmuch, we ſay, as we have brought ſome conſiderable Monuments of Obſervations much elder than that time; yet ſhall not concede beyond what the *Chaldeans* themſelves profeſt, when they teſtified to *Calliſthenes* (who went to them upon no other errand, by the perſwaſion of *Ariſtotel*, as *Simplicius* relates) that they had nothing of that kind among them beyond a thouſand nine hundred and Three Years paſt: which Years ſeem to commenſe at *Ninus*, the Sonne of *Belus*, and firſt King of the *Aſſyrians*. It is clear, that the Antiquity of Obſervations ariſeth to (but not above) one thouſand and ninety Years before *Alexander* the Great.

*in lib. 2. de Cœlo, and comment. 46.*

Artiel. 5. *Yet neither of them obſerved any thing conſiderable; as to the deſignation of Times: but corrupted what they had obſerved, to the introduction of* Aſtrology Judicial.

But, alas! after all this great adoe, *What did the Obſervations themſelves amount to?* Why truely, for ought we can gather from all that is extant concerning them, thoſe of the *Ægyptians* amounted to nothing at all: and thoſe of the *Chaldeans* to very little. For the *Egyptians*, we confeſs, are ſaid to have obſerved the riſing of the Dog-Star, and ſome other, no very difficult apparences: but we have no remains delivered down to us, of that or any other particular they obſerved, with the exact deſignation of the Time, as they ought. And from the *Chaldæans* we have as little, beſides thoſe *Eclipſes* mentioned in *Ptolomy*. But, when I ſpeak of the *Egyptians*, I except *Ptolomy* himſelf and ſome others, who lived and ſtudied at *Alexandria*, about there hundred Years before the Nativity of our Saviour; or after *Alexander*: as *Timocharis*, *Eratoſthenes*, *Hipparchus*: for all theſe were either *Grecians*, or to be accounted among *Grecians*, in reſpect of the language they uſed and wrote in, rather than among the ancient *Egyptians*, by whoſe Inventions even *Ptolomy* himſelf (one of their own Country men, without diſpute) was very little, or nothing at all aſſiſted in his Study of Aſtronomy. But, what concerns aſwell the *Egyptians*, as *Chaldeans*; their Obſervations are to be diſtinguſht (according to the diviſion vulgarly received) into (1.) *Aſtronomical*, and (2) *Aſtrological*: the former relating to the Motions, Magnitudes, Diſtances, and proportion of the Stars; the Latter to the Effects of them, which they conjectured were dependent on the Vertues

and

and Influences of Heavenly Bodies, aswell in the affections of the Air, as in the actions and affairs of Mankind. For, both Nations being wonderfully prone to *Superstition*, and surprised with excess of Admiration at the *Eclipses* of the Sun and Moon, when they first beheld them; and observing ever now and then some Stars that moved in Courses contrary to the *West*, they began presently to think, that those apparences hapned not without natural Causes; and that it remained only on Mans part, to Study how those events might come to be fore-known, which those apparences did portend. Hereupon, having attributed the most powerfull Vertue to the five wandering Stars (as *Diodorus* testifieth particularly of the *Chaldæans*) as understanding them to be the Proclaimers of the will and purposes of the Gods; because they sometimes arose, and sometimes set in various places of the Heavens; because they varied their magnitude and colour: therefore they conceived, that they ought to adress their *Studies* and Disquisitions principally to these varieties. And, because they imagined, that the higher the place was, from whence they should observe these Wandering *Stars*, the more clearly and distinctly might they be discerned; they builded *Structures* of vast altitude; and particularly that immense Tower at *Babylon*, described by *Herodotus*, from the highest area whereof (where stood also the Temple of *Belus*) they might exactly behold and observe the rising and setting of the *Stars*, and other *Syderal* occurrences. They took notice likewise, that those five *Planets* did keep almost the same Course, as the *Sun* and Moon; and thereupon they pointed out the Zodiack, imagining that there must be some eminent vertue in that part of the Heavens, because all the *Planets* kept constantly to it. And this Zodiack they divided into 12. parts, or *Signes*; because the Moon run it over 12. times, and the *Sun* only once, in one Year: and according to the number of the Dayes, during which the *Sun* was in passing through one *Signe*, they distinguished each *Signe* again into 30. parts, which we call Degrees. I shall not recount to you, how they would have Twelve Principal Dieties belonging to these 12. *Signes*, whereof each had his particular regiment over his proper *Signe* and Moneth dependent thereupon: nor how they substituted thirty of the fixt *Stars*, to assist the *Planets*, and called them *Concelling Gods*: nor how they placed 12. *Stars* always visible in the North, for goverment of

*loc. citat.*

*lib.* 1.

the Living; and as many more in the South, alwaies viſible, for the government of the Dead, there gathered together; with many other the like dreams and ridiculous abſurdities. But the thing I think moſt worthy your notice, is, *by what rude kind of artifice they diſtinguiſhed the Zodiack into 12. Signes*; as we find it deſcribed, concerning the *Chaldæans*, by *Sextus Empiricus*, and concerning the *Egyptians*, by *Macrobius*.

*ad Aſtrolog. 1.*
*in Somn. 21.*

The manner this. They took a veſſell with a ſmall hole in the bottom, and filling it with Water, ſuffered the ſame to diſtill Drop by Drop into another Veſſell, placed beneath to receive it; and this from the moment of the riſing of ſome one Star or other, obſerved in one Night, untill the Moment of its riſing again the next Night following. The Water fallen down into the Receiver, they divided into 12. equal parts, and having two other ſmaller veſſells in readineſs, each of them fit to contain one twelfth part of the Water, they again poured all the Water into the upper Veſſel, and ſtrictly marking the riſing of ſome one Star in the Zodiack, they at the ſame Moment gave the Water leave to diſtill into one of the ſmaller Veſſells, and ſo ſoon as that was filled, obſerving likewiſe another riſing Star, they put under another ſmall Veſſell; and ſo alternately ſhifting the ſmall veſſels, they noted, if not in one Night, yet in many, the twelve Stars, by which they might diſcriminate the whole Zodiack into twelve equal parts. Now with what Art and exactneſs theſe Ancients meaſured out the Heavens, may be conjectured from this one example. I might adferr another foppery of the *Chaldæans*, from the ſame *Empiricus*, who relates; that taking it for granted, that the future fortunes of Men did depend on their particular Horoſcope, or *Signe* riſing at their Birth: when they had a mind to divine in this Kind; Two of their wiſe men agreed together in the calculation of the Nativity of the Perſon propoſed: the one ſtood by the Mother in Travell, the other on ſome high place neer at hand; and as he that was below gave the *Signe*, that the Infant was then newly come into the World, the other above took care to obſerve the *Signe*, that was juſt then newly riſen. But, it will be of more uſe for us to hear what *Macrobius* tells of the *Egyptians*. They, when they would know the Diameter of the Sun, had in readineſs a Veſſell of Stone, hollowed to the form of an Hemiſphere, exactly made, with a ſtyle or Gnomen erected in the middle, and twelve Horary Lines drawn within.

*ibid. cap. 20.*

And

And on the very Day of the Equinox, observing the Moment, when the upper Limbus of the Sun first shewed it self above the Horizon; they marked that place on the brim of the Vessel, on which the Gnomen cast its shadow. Then again marking that place on which the shadow ended, when the lower Limbus of the Suns body appeared just above the edge of the Horizon; they measured the space or distance betwixt the two marks of the Shadowes, and found it to be the ninth part of an hour, or the hundred and eight part of the Hemisphere, and consequently the two hundred and sixteenth part of the whole Circuit: and from thence they deduced, that the Diameter of the Sun was the two hundredth and sixteenth part of its whole Orb; (which, in truth, is the 700th neer upon) or did contain one Degree and an hundred Minutes; which yet is no more than halfe a degree, or 31. Minutes, at most. To this we might super-ad, that it was the practice of elder times, to commensurate the Diameter of the Sun by an Hydrologie, or Vessel of Water; collecting the same from part of the Water flowing down the whole Day. which had dropped untill the Sun was wholly risen; as is insinuated by *Plutarch*, and deduced from *Capella*: but *Cleomedes* hath at large declared, that this way of measuring by Water falling slowly and equally from Vessel to Vessel, was an Invention of the *Egyptians*. Now the reason, why we touch upon these particulars, was only to satisfy, that (as we said afore) no great matter in Astronomy was ever observed either by the *Egyptians*, or by the *Babylonians*.

And, if you desire any further Argument thereof; Pray take this. They were very far from suspecting, that the Fixe Stars had any motion proper to themselves; or that they had any Eccentricity (excepting only that the *Egyptians* thought *Venus* and *Mercury* to move round about the Sun, as their center; as is affirmed by *Macrobius*, and some others) or that the Sun had any *Apogæum* at all, with many other Particulars fully as considerable. Which doubtless must be the reason, why they invented no *Hypotheses*, by which they might regulate themselves, in making their Caluclations of the various motions of the heavenly bodies. And *Peter Ramus* not long since complaind, that we have not our *Astronomy* free from the trouble of *Hypotheses*; such as the Interpreters of *Aristotel* themselves, and *Proclus* on *Timæus* have recorded the *Egyptians* and *Babylonians* to have had

had amongſt them: while, inſroth, he complaind, that we had not our *Aſtronomy* as rude wild and imperfect, as theirs was. For, however ſome *Hypotheſes* are more ſimple (and ſo more eaſy) than other-ſome: yet it is abſolutely impoſſible, that *Aſtronomy* ſhould conſiſt without ſome or other. Hereupon, they could obſerve, indeed, that the Planets were one while Direct in their Progreſs, another while Retrogarde, and then again Stationary; that they in their wanderings ſometimes inclined towards the *North*, and ſometimes deflected again toward the *South*: but all that while, they could neither comprehended the reaſons of thoſe various apparences, nor calculate them by numbers. The moſt they could doe, was darkly to repreſent thoſe motions, by certain *Hieroglyphicks*, as in particular by the windings and flexures of Serpents; and the motion of the Sun, by only a Beetle rowling his pill of dung backward: as we may read in *Clemens Alexandrinus*: and then came *Eudoxus*, who having learned that variety of motions among them, was the firſt who invented *Hypotheſes* of various Orbs, for the Solution of the *Phenomena*.

Again, they were very far from attaining the determinate places of the Fixt Stars, according to Longitude and Latitude; or according to their Right Aſcenſion, and Declination: ſo that neither could they define the true places of the Planets, by Comparation to the Fixt Stars, nor (conſequently) deſigne any Obſervations with due exactneſs. And truely, this was the Cauſe why *Hipparchus* met with no Obſervations, either of the *Egyptians* or *Babylonians*, by which he could receive the leaſt help or advantage, toward his compoſing either *Hypotheſes*, or Tables, to repreſent the motions of the Five errant Stars: and *Ptolomy* was the firſt, who partly by the benefit of Obſervations left him by *Hipparchus*, and partly by thoſe he made himſelf, became able to attempt ſuch a Work; as ſtands recorded in his *Almageſt*. There were only the *Eclypſes*, which both theſe Nations had ſet down: as obſerved in their Commentaries: and thoſe only ſo, as that from Paſt, they might be able to conjecture ſomthing of what were to Come. Not from the motions of Sun and Mon, exactly calculated by the help of Tables; but having learnd from common experience, that every nineteenth Year, *Eclypſes* did return again upon the ſame Day, for the moſt part: thereupon they endeavoured to prædict what *Eclipſes* would happen, and the time when; and this after they had perceived not any

*Ana-*

*Anomaly* in the *Sun*, but some certain Inequality in the Moon, which reducing to a medium, they concluded that the Moon did every Day run through thirteen Degrees, and a little more than one sixth part of a degree; as *Geminus* delivers of the *Chaldæans*. But in their predictions of *Lunar Eclipses*, they were somwhat more confident; aswell because these *Eclipses* usually uturn, for the three Ages next succeding, within the compass of the same Dayes; as because it is very rare, in respect of the greatness of the Earths shadow, but the Moon, either in the whole, or some part of her, more or less, falls into it: but, because (as to *Solary Eclypses*) the Moon is both so small, and hath so large a Parrallax, as that she doth not for the most part intercept the light of the Sun from the Earth; therefore was it (as *Diodorus* witnesseth specially of the *Babylonians*) that they durst not determine *Eclypses* of the Sun to come, to any certaine time; but if they predicted any, with limitation of time, they alwayes (to save their credit, in case of failing) annexed this Condition, *If the Gods be not prevailed upon, by Sacrifices and Praiers, to avert them.*

Truth is, these *Astronomers* were also Priests, and it was their interest to cast in this Proviso. For, being ambitious to be reputed interpreters of the Will of the Gods to the People, and so both knowing in things to come, and skillfull in such Ceremonies, wherewith their respective Deities were most attoned and delighted: unwilling to be thought able to predict nothing, and as unwilling again to be found erring in their chief predictions, they wrapt up all in Misteries, and amused the vulgar with superstitious opinions and rites. The *Egyptians*, in a great part of their sacred Worship, had recourse to the *Astrological* Books of their *Mercurius*, (one of the Order of the Fixt Stars; a second, of the Conjunction of Sun and Moon; a third and fourth, of their rising.) which with what ceremonious Pomp they used to carry about with them, in a kind of solemne Procession, you may find amply described by *Clem. Alexandrinus*. Nor is it strange that those Priests accounted so sacred and knowing, should also be esteemed for Prophets. Further, you meet with no mention of the Five Errant Stars, all this while; and the reason seems to be, because they attributed an energie of them only as they were referrable to the Inerrant or Fixt, and particularly, as they possest this or that part of some Signe in the Zo-

*lib. 6. Strom.*

diack, and together with it had their riſing, or ſetting. For, ſo much did they aſcribe to the Zodiack, as that the *Babylonians*, and (in imitation of them, the *Perſians* and *Indians*) thought, that each decimal of degrees, or thirds of the Signes, (and the *Egyptians* came as low as to each ſingle degree) could not be varied in the riſing, but ſome eminent variation muſt happen, eſpecially in him, who ſhould be borne at that time. And hereupon was it, that the *Egptians* made that great Circle of Gold (deſcribed in *Diodorus*) of a cubit in thickneſs, and three hundred ſixty five cubits in circumference (plundred at laſt by *Cambyſes*) that upon each cubits ſpace might be inſcribed each Day of the Year, 365. Dayes in the whole round, and alſo what *Stars* did riſe, what ſet upon each Day, nay the very hour of their reſpective riſing and ſetting, and what they did ſignifie: and whereas others uſed to aſſigne the form of ſome Animal or other, to each ten degrees; they aſſigned one to each ſingle degree, and ſo made their hariolations or conjectural predictions accordingly. For Example; to the firſt degree of *Aries* they aſſigned the figure of a Man, holding a *Sicle* or hook in his right hand, and a Sling in his left; to the ſecond, a Man with a Dogs-head, his right hand ſtretcht forth, and a ſtaff in his left; and ſo of the reſt: then annexing the ſignification to each, they determined, that he, who ſhould have the firſt degree of *Aries* for his Horoſcope, ſhould be ſome part of his life a Husbandman, and the reſt of it a *Soldier*; that he, who ſhould be born under the ſecond, ſhould be contentious, quarrelſom, and envious; and ſo of the reſt, all which *Scaliger* hath fully deduced from *Aben Ezra*. In a Word; what ever knowledge either the *Egyptians* or *Chaldeans* had of the *Stars*; certain it is, they referred it wholly to *Aſtronomantie*, or Divination by *Stars*: and therefore among them there flouriſht, no true and genuine *Aſtronomy*, but a ſpurious and falſe, one *i.e. Aſtrology Divinatory*, or the fraudulent Art of For tune-telling by the Heavens.

*Beroſus* (whom we formerly mentioned) coming into Greece, a little after the death of *Alexander*, is diſcovered to have brought with him nothing ſollid touching *Aſtronomy*, but only Judicial *Aſtrology*; for which, as a thing new, and ſtrange to the people, he was highly eſteemed, as *Vitruvius* and *Pliny* remark. And *Eudoxus*, who had returned out of *Egypt* before that, well knew what ſort of *Aſtrology* this was (the principal Contrivers and Founders

*lib. 9. cap. 7.*
*lib 7. cap. 37.*

of

of which are said to have been *Petosires*, *Necepsus*, *Esculapius* ) but he highly contemned it, as *Cicero* remembers, and brought home no other fruit of his tedious Travells, beside a list of some *Eclipses*, and the varieties of the motions of the wandering Stars, by which he first essaied to compose accommodate Hypotheses, as we have formerly hinted. Nay, *Plato* himself, who was Companion to *Eudoxus*, for thirteen Years together, in *Egypt*: profest: that he could attain nothing sollid and satisfactory, touching those Stars, and therefore placed all his hope only in the sagacity and industry of the *Grecians*, such as he knew *Eudoxus* to be. "For, having first recounted what ever he knew concerning "them; he saith, It is to beleeved that the *Grecians* make "more perfect whatsoever they receive from *Barbarians*; and "therefore is it fit, we allow the same, touching the argument "of which we have discoursed. Truth is, it is difficult to "find out the way, how all these Apparences, so involved in ob-"scurity, may be explicated: nevertheless there is great hope "that things of that sort will be better and more advantageous-"ly handled, than they were delivered to us by *Barbarians*.

*2. de divinat.*

*in Epinom.*

From the *Egyptians* and *Chaldeans*, therefore ( as *Astronomy* her self, while young and rude ) we come to the *Gracians*: and the most antique record of Syderal Observations to be found among them, seems to be that of *Hesiod*; who in his Book of Weeks and Dayes teacheth Husbandmen the most opportune times of reaping, sowing, and other labours of Agriculture, from the rising and setting of the *Pleiades*, and *Hyades*, and *Arcturus*, the *Dog-star*, and *Orion*:

Articl. 6. *And after them to the* Grecians *among whom the most ancient mention of Astron. is in* Hesiod.

Πληϊάδων Ἀτλαγενέων ἐπιτελλομενάων.

*Donec Pleiades, quæ & Atlantiades, exoviuntur, &c.*

And I cannot tell, whether it were that book, or some other, that *Pliny* meant, when speaking of *Hesiod*, he sayes, *Hujus quoq;, nomine extat Astrologia*, there is extant an *Astrology* of his. However, we are here to remark two things, in order to our more exact disquisition; the *First* is, that the Ancient *Greeks* principally attended to these risings and settings, aswell that they might distinguish the several Seasons of the Year, as that they might fore-know Rain, Winds and other dispositions of the Air, usually attending those Seasons. And hereupon, *Thales*, *Anaximander*, *Democritus*, *Euctemon*, *Meton*, *Eudoxus*, and many

*Ex Gem Ptol. & aliis.*

many others, compoſed certain *Parapegmata*, Tables, (as Ephemerides, or Diaries) in which they inſcribed each Day of the Year, with the particular Stars riſing or ſetting on each Day, and what mutations of the Air each one did portend. Such a Parapegme as theſe, was compoſed likewiſe by *Julius Cæſar* himſelf, for the Horizon of *Rome*; in alluſion where-to he might juſtly own, what *Lucan* ſaid for him, *lib.* 10.

*Nec meus Eudoxi faſtis ſuperabitur Annus.*

And, him doubtleſs, did *Ovid* tranſlate into his *Faſti*; promiſing in the beginning, that he would ſing of the Stars and Signes, that roſe and again deſcended under the Earth. But, to keep cloſe to the *Grecians*; among them, he was held a great Aſtrologer, who had diſcovered and obſerved only theſe riſings and ſettings here ſpoken of; and ſo of whom that might be ſpoken, which *Catullus* ſaid of *Conon*, *lib.* 1.

*Omnia qui magni diſpexit lumina Mundi,*
*Stellarumq; ortus comperit, atq; obitus.*

For, before the Advent of *Beroſus*, this was the only [Ἐπισημασία] Præſignification or Divination by the Stars, the *Grecians* had among them: unleſs what *Heſiod* hints, in his *in diebus.*

Πρῶτον ἦμαρ τετ'ς ἑβδόμη, ἱερὸν ἦμαρ,
*Primùm prima dies, & quarta & ſeptima ſacra, &c.*

where he points out, what Dayes of the Moon were accounted Lucky, and what Unlucky.

The *Second* obſervable is; that among the *Grecians*, and indeed among divers other Nations, beyond all Memorials of either Traditions or books, the Stars were reduced to certain Images, or Conſtellations, and denominated accordingly (as their names yet ſhews) as it pleaſed the fancies of Husbandmen, Shepheards, Mariners and the like, who uſed to be vigillant and gazing upon the Heavens in clear Nights. Though there have been ſome Conſtellations added of latter times, as that of the leſſer *Wain*, by *Thales*, which *Laertius* and *Tatius* recite out of *Callimachus*, who alſo took the ſame elſwhere, and that of *Be-*

*lib.* 1. *de vit. Hiſt. & de Com. Lat. n.*

*renices*

*renices Hair*, removed into Heaven by *Conon*, as *Catullus* relates. *Cleostratus* likewise (as we have it from *Hyginus*) found out the *Kidds*: though, (which *Pliny* moreover attributes to him,) his invention of the Signes in the Zodiack, is so to be understood, as that he taught men through what Signes the Sun and other *Planets* passed. But (that we may touch also upon this) at first, the *Grecians* had only Eleven Signes in their Zodiack; and it was long after ere they came to add the twelfth, in imitation of the *Egyptians*, who (as may be collected from *Servius*, *in Marcianus*, and others) in stead of the *Claves* of the *Scorpion*, placed *Libra*, the place destined to *Augustus*, by *Virgil*,

*lib. 2. Astron.*

*lib. 2. cap 8.*

*1. Georg. l. 8.*

*---- Ipse tibi jam brachia contrahit ardens Scorpius. ---* 1. Georg.

They added the Twelfth, we say, to the end, that as the whole Compass of the Zodiack was divided into *Dodecatemoria* (as they call them) twelve equal parts, so it might consist also of twelve Signes. Albeit, being (as it were) necessitated to make use of such Signes, as had been brought up, rather by chance, than Art; those 12. Signes were not exactly proportionate to the 12. Divisions of the Zodiack, but took up more space some, than others: as in particular, *Leo* possest more room than *Cancer*; *Taurus* than *Gemini*. I say, than *Gemini*, which though composed of *Castor* and *Pollux*; in so little space as is allowed them, it is impossible the one should rise, when the other sets, and both in the *East*: but this *Empiricus* interprets of the two *Hemispheares*. I omit to insist upon this, that all Nations had not the same Constellations: as among the *Egyptians* was no *Bear*, no *Cepheus*, no *Dragon*; but other formes or representations, as *Tatius* reports; and shall add only, that *Eudoxus* seems to have been the first, who partly out of the *Egyptian* Figures, partly out of the *Grecian*, furnished the whole Zodiack with Images resembling the *Asterismes*, (as men had fancied, at least) and caused them to be drawn on a Globe, or solid Sphear. For, *Aratus* (upon whose Poem, intitul'd *Φαινόμενα*, *Apparences*, there have been so many Commentaries set forth, as that no fewer than forty have been extant in Greek; besides those of *Cicero*, *Germanicus*, *Avienus*, and other Latin Interpreters.) did no more, but only express in verse, what *Eudoxus* had said before in prose, of this argument; as *Hipparchus Bythinus* de-

1. *advers. Physic.*

*lib. 1. in Arat. Phæn.* monſtrates. I know not, whether it would be ſeaſonable for me, here to advertiſe, that it is no wonder *Aratus* erred ſo groſly in many particulars; conſidering that (as is written in his life) he Living with *Antigonus Gonata*, in the quality of his Phyſician, and *Nicander* in the quality of his *Aſtrologer*; and both were good at Poetry: *Antigonus* commanded the Phyſician to give him a tryall of his Poeſie, upon an Argument in *Aſtrology*; and the *Aſtrologer* to give another of his, upon ſomthing in *Phyſick*: delivering to the one, the Book of *Eudoxus*; and to the other, all that was extant of *Treacles, Antidotes*, or *Counterpoiſons*. So each wrote of what he did not well underſtand. One thing I ſhall not forget; and that is, that the *Phenomena* of *Euclid*, who lived neer about the ſame time, and taught at *Alexandria* (as in the Memorials of *Pappus*) were quite of another kind; being indeed no other, but certain Principles of *Aſtronomy*, concerning the figure of the World, and the Circles of the Sphear, and chiefly, that of the Zodiack.

*lib. 7.*

*and next of* Thales Mileſius.

But, to return back to the more primitive *Greeks*; I remember I ſaid, that *Thales Meleſius* was accounted the Firſt, who after old *Heſiod* and *Homers* Dayes, enquired into the Order of the Stars. And, certainly He was the Man, who among the *Grecians* may challenge the Palme; as to Antiquity; for, *Apuleius* calls him, *ut antiquiſſimus, ſic peritiſſimus Aſtrorum Contemplator*, and *Eudemus* in *Laertius* atteſteth, that this was the Opinion of moſt, adding moreover, that *Xenophanes* and *Herodotus* highly admired him, for that he had firſt predicted the *Eclypſes* and Converſions of the *Sun*; and that *Heraclitus* and *Democritus* witneſſeth as much. And whereas *Apuleius* further ſubjoyns, that he found out the motions and oblique tracts of the *Syderal* Lights: *Pliny* aſcribes that to *Anaximander*, a Diſciple of *Thales Mileſius*, (whence he was ſaid *Rerum fores aperuiſſe*, to have opened the Doors of Celeſtial matters) and *Diodorus* to one *Oenopides Chius*: which *Thales* could not yet be ignorant of the Obliquity of the Zodiack, when he had written of the *Solſtices*, and *Equinoxes*, and had converſed a long time with the *Egyptians* in their own Country, as *Laertius* remembers. Further, it is delivered to us, that among others, he predicted that notable *Eclipſe* of the *Sun*, which hapned in the time of the warre betwixt the *Meads* and *Lydians*; which he could not doe by any other reaſon, but only becauſe, coming

*lib. 1.*

newly

newly out of *Egypt*, he had learned, that *Eclipses* generally return upon the same Day after the space of nineteen Years; and having taken notice of one, that fell out 19. Years before, he concluded that there would be one at such a time. Nor is there reason why any should think, that otherwise his whole life might be sufficient to observe all the motions of the Sun and Moon, as from thence to be able to invent all things necessary for the calculation of the times of their Several *Eclipses*. Moreover, it doth not appear, how by any other way, but that *Helicon Cyzicenus* came afterward to fore-tell that *Eclipse* of the *Sun* (mentioned in *Plutarch*) for which he was so much admired by *Dyonisius*, and rewarded with a Talent of Gold. Nor likewise, how *Sulpitius Gallus* could fore-tell that other of the Moon, which as most opportunely predicted to the *Roman* Army, then ready to joyne battell with the *Persian*, is so higly celebrated, not only by *Plutarch* and *Pliny*, but also by *Valerius*, *Quintilian*, and other Historians: for other Rule for the calculation of future *Eclipses*, there was none before *Hipparchus*, who invented Hypotheses and Tables fit for that purpose. Besides, what *Laertius* imputed to *Anaximander*, *Plinius* as confidently imputes to one *Anaximenes*, an Auditor of his: (namely that he should be the Inventor of that *Gnomon*, by which the Conversions of the *Sun*, or the *Solstices* and Equinoxes, were indicated; and that he set up such a one at *Lacedæmon*.) Neer upon the same time was it, that *Pythagoras* is said to have first discoursed (though *Phavorinus*, in *Laertius*, confers that honour upon *Parmenides*,) that *Lucifer* and *Vesper* was one and the same Star of *Venus*. Now, whether may we conceive, that he borrowed this of the *Egyptians*, from whom being taught, that not only *Venus*, but *Mercury* also, were carried round about the Sun, as their Center, so that one and the same might be both Morning and Evening Star: possibly, from thence he might take the hint of his Conjecture, that the *Sun* was the Center of not only those two, but of the other Planets also, and consequently of the whole World: and moreover that the Earth it self, as one of the *Planets*, moved about the *Sun*? For truely, this was an eminent and constant Tenent in his School; as may be understood not only from *Aristotle* in the general, but also from *Laertius* in particular of *Philolaus*, and from *Archimed.* of *Aristarchus*, both *Pythagorus* his Disciples: that we may not rehearse all those many passages in

*in vit. Dionys.*

*then of* Pythagoras, *and his Disciples.*

2. *de cœlo.* 13. *de Arenar. num.*

{Philolaus, Ariſtarchus, Timæus.} in *Plutarch*, concerning this memorable particular; nor name thoſe, who held, that the Earth was not ſo much moved about the Sun, as dayly turned rouud upon an Axis of its own; as *Timæus*, a *Pythagorian* alſo, who is therefore by *Syneſius* eſteemed, after *Plato*, the *moſt excellent Aſtronomer*.

*de don. ad pæon. in Timæum.*

*After theſe ſucceeded* Cleoſtratus.

Furthermore, in the next Age after *Thales*, or neere upon, comes *Cleoſtratus* (the ſame who was beleeved to have deprehended the *Signes* of the *Zodiack*) and he, ſeriouſly remarking that the Intercalation, which as we ſaid, was wont to be made every fourth Year, celebrated with the Olympick Games, did indeed reſtore the motion of the Sun to the ſame Day again; but did not reſtore the motion of the Moon till the eight Year, or two Olympiades, in which the intercalatory Dayes amounted to ninety Dayes, or three months: He, we ſay, thereupon interduced, inſtead of the *Tetaeteris*, or ſpace of four Years, the *Octaeteris*, or ſpace of eight Years, which compleatly paſt, the New-Moons, and Full-Moons would returne again on the ſame Dayes. But, when in ſhort time men had perceived, that this Inſtitution failed them, in exactneſs of computation; and that ſundry wayes had bin attempted to cure this uncertainty: at length riſeth up *Meton*, ſomwhat more ancient than *Eudoxus*; and he demonſtrateth from the New-Moons, and Full-Moons Eclyptical, that they did not return upon the ſame Dayes, till after full nineteen Years: and thereupon he became the Author of the *Enneadecaeteris*, or *Period*, or *Cycle* of 19. Years. In reſpect of which diſcovery, together with the Heliotrope, or Sun Diall he made at Athens, and ſome other the like Inventions, he was in eminent eſteem among the *Athenians*. But as concerning that *Period*; *Callippos*, familarly acquainted with *Ariſtotle*, diſcovering it to be too long, by the fourth part of a Day; inferred, that from four Periods one whole Day ought to be detracted: and ſo erected a new Period, or Cycle of *Sixty* ſix Years, or four times nine, at the end of which one Day was to be cut off; and this was called the *Callippik Period*, and remained in uſe for a long time together. After him ſucceeded *Hipparchus*, who detecting this *Period* to be yet too long; demonſtrateth that after four *Callippik Periods*, or three hundred and four Years, there would remain one whole Day too much. And in truth, the experience of many ſucceding Ages declared, that to this detraction of *Hipparchus*, nine or ten Years over and above were to be expected.

*Meton. &c.*

How-

However, it is worthy our notice, that the *Period* of *Meton*, together with the Conection of it, applied by *Callippus*, was of long use in the Church under the name of the *Golden-Number*: though wanting the Application of *Hipparchus* his Correction: also, a mistake of about four Dayes, relating to the New and Full Moons, crept into the account, even from the time of the *Nicene* Councel; which was one of the two main causes of the Reformation of the Kalender in the eighty second Year of the last Age.

Artiel. 7. Eudoxus, *who first discovered the necessitie of manifold* Spheares.

And now we have an opportunity to speak more expressly of *Eudoxus*, so frequently mentioned. This man, well understanding, after his return out of *Egypt*, that not only the Sun and Moon, but also the five Errant Stars, did keep their courses round in the Zodiack; and so, as that aswell the Sun and Moon, as those wandering Stars did sometimes vary their latitude, or deviate from the *Ecliptick* Line in the midle of the Zodiack; (for, he thought that the Sun was also extravagant, as well as the rest; and again, that the other Planets did not only go forward, but were also some times upon their retreat backward; and somtimes made a haulr or stood still: we say, pondering all these various motions in his mind, and casting about what might be the reasons thereof in nature; he at last imagined to himself, that besides the *Aplanes* or *S*phear of Fixt Stars, which being supreme, carried all the rest toward the *West*, there ought also to be allowed three other Sphears, aswell to the Sun, as to the Moon, and four to each one of the other Errant *S*tars; of which one, and that the highest, should follow the Impression of the Fixt Stars, or rather of the *Primum Mobile*; the next to that should move counter to the First, or toward the *East*; the third make the deviation from the *Ecliptick*, or midle of the Zodiack; and the fourth, or lowest, cause in the *S*tars their Direction, Station and Retrogradation, and that by a certain Vibration, or Waving to and agen. So that he supposed in all, twenty seven *Sphears*, and all those Concentricall, that the Superior might carry on the Inferior, and these might be turned round within those. Afterwards, *Callippus* adjoyned two *Sphears* to the Sun, two to the Moon, and one a peece to *Mars*, *Venus*, and *Mercury*: and so made thirty three. And *Aristotle*, to all the *Sphears*, which did not follow the motion of the *Aplanes*, or *Primum Mobile* (excepting only the Lunar *Sphears*) added as many more, which he called the Revolvent ones, to the end he might conform them to the mo-

tion of the Inerrant *Sphear*, or *Primum Mobile*: and so in the whole he constituted Fifty six *Sphears*; for as much, at least, as we can collect from his own context. Now all these, and even *Plato* himself likewise, thought that the Moon was the lowest of all the *Planets*; next to her, the *Sun*; and above the Sun the five wandering Stars. Nor indeed doth it appear, that *Archimedes* himself, Living a whole Age or two after them, represented the *Planets* in any other, than this very order, in that so famous *Sphear* of his. In which though *Claudian* tells us, that no more was represented, but only the motions of the Sun and Moon;

*in Epigram.*

*Percurrit proprium mentitus Signifer annum,*
*Et simulata novo Cynthia mense redit:*

Yet *Cicero* adds other motions, when speaking of *Archimedes*,

2. *de divinat.* "he saith; when he collected together the motions of the "Moon, Sun, and five wandering Stars; he did the same as that "God, who in *Platoes Timæus* framed the World, that one and "the same Conversion might regulate sundry motions, most dif-"ferent each from other in slowness and swiftness. But, *Hipparchus* afterwards finding, that aswell the Sun, as the Moon and the other five Stars did come sometimes nearer to the Earth, and sometimes again mounted up farther from it; and plainly perceiving that that particular apparence could not possibly be explicated by those *Sphears*, that were all Concentrical to the Earth: therefore, wholly rejecting them, he resolved, that the motions of the *Planets* were to be accounted Eccentrick; and though he could not himself determine each particular, he yet demonstrated the way, in which *Ptolomy* afterwards insisting, accomplisht the Invention. But, before wee advance further, we are to commemorate two or three Persons of note, by whose Observations both *Hipparchus* and *Ptolomy* profited very much. One was *Timocharis*, who, about three hundred Years before Christ, among other things relating to the Fixt Stars, observed that that Star which is called *Spica Virginis*, doth antecede the point of the *Autumnal Equinox*, by eight degrees. And with him are we to joyn *Aristillus*, whose Observations of something about the Fixt Stars *Ptolomy* made great use of, in order to his demonstrating that the Fixt Stars never change their latitude. Afterwards, scarce

an

in Age) succeded *Eratosthenes*, who being *Library-keeper* to *Ptolomy Evergeta* the somer, perswaded him to set up the *Armilla* in the *Porticus* of *Alexandria*; which *Hipparchus* and *Ptolomy* afterwards made use of; and himself, among other things observed, that the Obliquity of the Zodiack was of twenty three degrees, and fifty one minutes; which account *Hipparchus* and *Ptolomy* constantly adhered to. Prolom. *lib.* 1. *cap.* 11.

Article. 8. Hipparchus, *who first observed the places of the Fixt Stars, according to Long. and Latitude.*

Now that we may at length remember the great *Hipparchus*, who florish't neer upon an hundred and forty Years before Christ: truely, we find it no easy task to recount, how highly *Astronomy* was beholding to him. For, in the first place, examining that foresaid Observation of *Timocharis*, with some others; albeit he could not conceive them to be in all points exact, yet because himself had found that *Spica Virginis* did not antecede the Equinoctial point by more than six degrees, and the other Stars in the like Proportion: he thence understood, that the Fixt Stars also were moved Eastward according to the Zodiack; and thereupon wrote a Book, of the *Transgression of the Solstices & Equinoxes*. And, being that in his time, as not long agoe in *Tycho Brahes*, there appeared a certain New Star, "he therefore came to doubt (to speak the language of *Pliny* "concerning him) whether the like happened often, or not; and "whether those Stars, that were thought to be fixt, had also some "certain motion peculiar to themselves. Wherefore (as the same "*Pliny* goes on) he attempted a task of difficulcy sufficient even "for the Gods themselves, namely to number the Stars for Poste- "rity, and reduce the heavenly Lights to a rule, so that by the help "of Instruments invented, the particular place of each one, together "with its magnitude, might be exactly designed: and where- "by men might discern, not only whether they disappeared, or "newly appeared, but also whether they removed their Stations; "as likewise, whether their magnitude encreased, or diminished; "Leaving Heaven for an Inheritance for the Witts of succeding "Ages, if any were found acute and industrious enough to com- "prehended the mysterious orders thereof. And this was the first time when the places of the Fixt Stars were observed and markt out according to Longitude and Latitude: and that Catalogue of the Fixt Stars, which he composed, is the very same, which *Ptolomy* afterward inserted into his *Almagest*. In the next place, he denoted was positions sundry Stars had in respect *lib.* 2. *cap.* 26. *lib.* 7. *cap.*

each of other; whether they were poſited in a right Line; or in
*ibid cap.* 1. a triangular form; or in quadrate or ſquare, &c. as is manifeſt even from *Ptolomy* himſelf. Further, though the motions of Sun and Moon were already in ſome meaſure known; he yet made that knowledge much more exact. For, He did not only much correct the *Callippick Period*, formerly ſpoken of, but alſo, having collected a long Series of *Eclipſes* (namely, from the time of thoſe *Babyloniſh* ones, in the Dayes of *Mardocempades*, down to thoſe obſerved by himſelf, for full ſix hundred Years together.) and remarking, that neither the like *Eclipſes* did return on the ſame Dayes, after the ſpace of every nineteen Years, nor that after ſome recurſes of ten *Novennales*, or ten times nine Years, any ſuch *Eclipſes* happened at the times ſuppoſed; and that the cauſe thereof conſiſted both in the various Latitude of the Moon, and the anticipation of her *Nodi*, or Knotts, and her Eccentricicy, by reaſon whereof her motions to her *Apogeium* were found to be ſometimes ſlower, and thoſe to her *Perigeium* more ſpeedy: therefore, we ſay, He comprehended and gave Reaſons for all theſe difficulties, and compoſed certain Hypotheſes, and according to them, certain Tables, by which he could ſafely and exactly calculate and predict what *Eclipſes* were to follow, how great they were, and when. And this was it, which *Pliny* remembred, when having ſpoken of *Thales*, and *Sulpitius Gallus*, he comes to mention *Hipparchus*. After "theſe (ſaith He) *Hipparchus* foretold the courſes of both Luminaries, for ſix hundred Years to come; comprehending the "months, Dayes and hours of Nations, and the Scituations of "Places, and turns of People: his age teſtifying, that he did all "theſe great things, only as he was partaker of Natures Councels. For, it muſt be, that *Hipparchus*, beſides the preciſe times, when ſuch or ſuch *Eclipſes* were to be viſible to the Horizon of *Rhodes*, or *Alexandria*, pointed forth alſo ſome Countries, and principal Cities, together with the Deſignation of the Months in uſe among them; as alſo the very Days and hours when each *Eclipſe* would happen; and other prædictions ſucceding to *Rome*, in the Dayes of *Pliny*.

*He alſo corrected the* Callippick Period, *and predicted future* Eclipſes, *for* 600. *Years together.*

Again, it is well worthy our recital, that *Hipparchus* labouring with long deſire both to conſtitute *Hypotheſes*, and reduce into Tables the motions of the other *Planets*, or five wandering Stars; and yet not being able to furniſh himſelf either from the *Egyptians*, or from his Country men the *Grecians*, with any com-

competent Observations respective to those *Planets*, (for while the places of the *Fixt Stars* remained unknown, it was impossible any such could be made) and again those he had himself made, were of a much shorter time, than was requisite for the establishing any thing certain and permanent in that sort: He therefore only digested such Observations as he had recorded by him, into the best order and method he could devise; and so left them for their use and improvement, who should come after him, in case any were found capable of understanding and advancing them. And at length, by good fortune, it so fell out, that those his Observations came into the hands of *Ptolomy*; who comparing them with his own, and finding them judicious and exact, thereupon first began to erect both *Hypotheses*, and Tables of Motions fit for those *Planets*: yet not without much timerousness and diffidence; because his Observations being but few, nor of sufficient time, he durst not promise himself any certainty of his Tables for any considerable space, or number of Years. But, for more assurance let us hear his own ingenious Confession in that point. The Time (saith He) from whence *Almagest. lib. 9 cap 2.*
"we have the Observations of the *Planets* set down, is so vastly
"short, in comparison of the greatness of Cœlestial vicissitudes,
"as that it renders all predictions, that are for any great number
"of Years to come, infirm and uncertain. And therefore I
"judge that *Hipparchus* (that zealous lover of truth) considering
"this difficulty, and withall receiving not so many true Obser-
"tions from the Ancients, as he bequeath'd to us, undertook
"indeed the business of the *Sun* and Moon, and demonstrated
"that it might be performed, by equal and circular motions: yet,
"as for that of the *Planets*, those Commentaries of his, which
"have come into our hands, clearly shews, that he attempted it
"not: but collecting all his own Observations concerning them
"together, into one order and method, for their more commodi-
"ous use, resigned them to the industry of after times; having first
"demonstrated, that they were not congruous to those *Hypothe-*
"*ses*, which the *Mathematicians* of those Dayes made use of.
"And, for Others; sure I am, that either they demonstrated
"nothing at all, or else only attempted the business, and left it un-
"finisht. But, *Hipparchus* being eminently knowing in all
"kinds of learning, conceived, that he ought not (as others had
"done before him) to attempt, what he should not be able to

accomplish. So that we see, *Ptolomy* was the first, who from true Observations, reduced the Motions of the *Planets* into *Hypotheses* and Tables correspondent.

Articl. 9.

*Betwixt* Hipparchus *and* Ptolemy, *came* Sosigenes, *of* Alexandria, *by whose help* Jul. Cæsar *endeavored the reformation of the Calendar.*

But before we speak more particularly of him, who lived about an hundred and thirty Years after Christ; forasmuch as in the space of time betwixt *Hipparchus* and *Ptolomy*, these studies so florisht at *Alexandria*, as that *Julius Cæsar* returning thence, brought along with him that *Sosigenes*, by whose assistance he endeavoured the restitution of the *Calendar*, and so may be thought to have propagated the Study of Astronomy among the *Romans*: let us reflect a little upon that time, and see what care they then had of Celestial matters. In the first place, we are to lay aside the Commemoration of *Sulpitius Gallus* (of whom more then once afore, as one that falls not under this account, concerning whom we may not yet forget, what *Cato* is induced by *Cicero*, saying. While we saw that *Gallus* dye, that familiar friend of thy Father, *O Scipio*, who was restless in measuring Heaven and Earth; I say, while we saw him dying even in that Study. How often did Day oppress him, when he had set himself to observe and describe somthing in the Night? and how often did Night oppress him, when he had begun his Speculations in the Morn? How was he delighted, when he had a long time before predicted to us *Eclipses* of the Sun and Moon? &c. For he was a man clearly singular, and in an Age when so great ignorance and neglect of good Arts tyrannized over mens minds, being himself studious and inquisitive, could not but have borrowed his skill either from *Egypt* or *Greece*, where having obtained a *Series* of *Eclipses*, and the way of deducing them through the circuit of of nineteen Years (as we said afore) he became able to calculate them, so as *Cicero* relates For, as to the rest; how great doe you think was the ignorance and neglect, nay even contempt of studies of this nature among the *Romans*? Why, truely so great, as that *Virgil* could not dissemble it, in the Poesy attributed to *Anchisa*, according to which the *Romans* should indeed come to rule the World; but yet should yeeld to others, in learning to know the Stars, and describe the Heavens,

- - - - - - - - - - - - *Cæliq; meatus*
*Describent radio, & surgentia sidera dicent.*

6. Æneid.

And *Cato* himself is cited by *Agellius* to have left in writing that

that it was not lawfull to write what is in a Table kept by the High Preist, how often ſcarcity of Proviſion would happen, how often the light of the Sun, or Moon ſhould be darkned: ſo far, ſaith *Gellius*, did *Cato* contemne the Science of *Aſtronomy*, and thought it uſeleſs either to know, or fore-tell the *Eclipſes* of Sun and Moon. Furthermore, though from times as high as *Numa*, the *Romans* made ſeveral Intercalations; yet they took all their art of that Sort, from the *Greeks*: and *Pliny* remarks, that in *France*, *Spain* and *Africa*, there was no one man, who could ſo much as tell the Riſing of the Stars. Nevertheleſs we are not to forget, that among the *Gauls* was one *Pythias*, the *Philoſopher* (as *Cleomedes* calls him) of *Maſilia*, who about the time of *Alexander* of *Macedon*, found the proportion of the *Gnomon* to the Solſticial ſhadow, to be the ſame at *Maſſilia*, as *Strabo* tells us *Hipparchus* had obſerved it at *Byzantium*; who firſt attempted the *Northern Ocean*, and diſcovered the utmoſt *Thule*, in which *Cleomedes* cohærently proves the Summer Tropick to be the ſame with the *Polar*, or greateſt of allwayes apparent ones: and who (as from his Book, *de Oceano*, may be inferred) was excedingly curious to find out what was the Poſition of Heaven, reſpective to the variety of Countries and Climates. But, not ſo ſoon to digreſs from the *Romans*; *Pliny* delivers, that in thoſe firſt times of *Romes* being a Common-wealth, the Invention of Dialls was very raw and imperfect: for that they had only the riſings and ſettings named, out of twelve Tables. That after ſome Years, they added the Meridian, and by the indication of a certaine columne, the laſt hour: nor that neither, but only in clear weather, even as long as till the firſt *Punick* warre. Afterward they advanced ſo far, as to make one, or two Sun Dialls; but not with lines exactly correſpondent to the hours, untill about an Age after, when *Q. Marcus Philippus* ordered the buſineſs more diligently and ſucceſsfully. And, becauſe the hours of the Day remained yet uncertain in dark and cloudy weather, *Naſica Scipio* began to divide the Hours of Day and Night equally by Water diſtilling from Veſſel to Veſſel, and called it *The Diall within Doores*, in the Year *Urbis conditæ DXCV*. And till then, ſaith *Pliny*, *Populi Romani indiſcreta lux fuit*. And thus much of *Hipparchus*, and ſome *Aſtronomers* betwixt him and the Prince of them all, *Ptolomy*.

*lib. 2. c 28.*

1. *Meteor 7.* Pythias Maſſilienſis, *a Gaul, and contemporary to* Alex. *of* Maced.

*lib. 7. cap. 60.*

Quintus Marcius Philippus, *&c.*

Naſica *Scipio*, Romans.

And of him, ſo great is his name, all we need to ſay, is only, that Article 10.

Ptolemy, *the true Founder of* Aſtronomy *in one intire ſtructure.*

that He was the *very Founder of the* Art, *or Science of* Aſtronomy. For, though *Hipparchus* had indeed, as it were hewn out the Stones and Beams fit for ſo noble a Structure, and prepared good part of the Materials; yet was it *Ptolomy* alone who put them into Order and Form, and by adding many admirable Inventions of his own, by infinite labour and coſt, erected that ſo famous Building, worthily called Μεγάλη Σύνταξις, *the great Co-ordination, Conſtruction, or Compoſition*; which conſiſting of no leſs than thirteen Books, contains all the Doctrine, that could then be advanced, concerning the Sun, Moon, and aſwell the Fixt, as wandering Stars. And, albeit one Day teacheth another, and that (as Himſelf had truely foretold) there came others after him, who ſaw good cauſe for the Caſtigation and Correction of many things delivered in that Work: yet, in the general, the Art he had inſtituted, remained firm and conſtant, and was afterwards imbraced, not only by the *Alexandrians*, but alſo by all the *Arabians*, Latins and others, who devoted themſelves to the ſervice of *Urania*, ever ſince. For, that the Study of her Celeſtial myſteries continued in great eſteem and Veneration, at *Alexandria*, for ſome Ages after his deceaſe, may be undeniably atteſted,

*Who next reſigned it to* Theon *and* Pappus, *both* Alexandrians.

not only from hence, that (among others) both *Theon*, and *Pappus*, named *Alexandrians*, were eminent therein; of which the one put forth eminent Commentaries upon *Ptolomies* Works, and the other, among ſundry excellent peeces, of which his ſixth Book of *Mathematicall Collections* is one, obſerved, that about four hundred Years from Chriſt, the *Obliquity* of the *Ecliptick* was not ſo great, as *Eratoſthenes*, *Hipparchus* and *Ptolomy* had conceived: but neer upon the ſame we diſcover it to be in our Dayes: we ſay, that this is not the only Monument that is extant of the flouriſhing of *Aſtronomy* at *Alexandria*, long after *Ptolomy* had given it ſo great a Reputation there; but there remains another as freſh and lively, which is the memorialls of thoſe *Patriarchs* of the *Alexandrine Church*, to whoſe judgement the determination of that great diſpute about the true time of Eaſter, was thought fit to be wholly referred, aſwell by the *Nicene Councel*, as by divers learned *Biſhops* afterward, and by Holy *Leo* himſelf, then Pope. Now, among theſe *Patriarchs* were *Theophilus*, *Cyrillus and Proterius*, whoſe advice and directions were thought neceſſary, in regard that the Controverſies raiſed about the Celebration of *Eaſter*, about the time of the *Veneral* Equi-

Equinox, about the Full-Moon next following, and about constituting certain constant Rules respective to them; could not be better composed, than by the definitive sentence of these Prelates, who Living at *Alexandria*, where *Astronomy* was in such Height, had the advantage of others, in point of knowing those things which were requisite to the finding out of the truth. But, of the *Arabians*, who in the *S*tudy of *Astronomy* succeded the *Alexandrians*, and translated into their own language, the *Great Composition* of *Ptolomy*, which they called *Almagestum*; the First, and most worthy to be remembred, was *Albategnius* otherwise called *Mahometes Aractensis*, born of a Family of the *Dynasta* of *Syria*; He about 800. Years after Christ, made divers Celestial Observations, partly at *Aracta*, and partly at *Antioch*: and found, both that the Apogeium of the *S*un, since the Dayes of *Ptolomy*, was advanced to the following *S*ignes; and that the *S*tars did regress toward the East, one degree, not in the space of a hundred Years, as *Ptolomy* also had designed; but of somwhat less than seventy; as also, that the Obliquity of the *Ecliptick*, according to *Pappus* his Theory, was less (*viz.* above 23. degr. 35. minutes) with many other particulars concerning aswell the Fixt *S*tars, as the Planets: whereupon he both corrected *Ptolomy* in many things, and composed new Tables, and wrote a Book intituled, *De Scientia Stellarum*. After him, within 2 or 3 Ages following, succeeded *Alphraganus*, *Arzachel*, *Almeon*, and other *Arbians*; among whom, (as being already tainted with that superstition which had corrupted the simplicity of *Astronomy*, with *Astrological* Fooleries) some certain *Jewes*, as ambitiously affecting the glory of Divination as the others, intermixed themselves.

*and long after.* to Albategnius, *then to* Alphraganus *and other* Arabians.

After them, for a long time, the Worship of *Urania* lay neglected, nor did *Astronomy* receive any the least (considerable) advantage by Observators; till neer about four hundred Years since, *Alphonsus* King of *Castile* and *Lion*, being himself also toucht with the curiosity of *Astrological* predictions, and discovering that the Tables aswell of *Ptolomy*, as *Albategnius* were not exactly agreeable with the Celestial motions; set himself to the composing of new ones; and to that purpose convocated as many *Arabians* and *Jewes*, as were eminent in those Dayes for *Astronomy*; imploying them about Observations necessary to so great a Work, and comparing with them those of their Predecessors,

Articl. 11. Alphonsus, *K. of Castile, who made and named the* Alphonsine Tables.

that ſo they might be the more exact in the performance of their task propoſed. And very memorable it is, that (as hath been credibly reported) He ſpent four hundred thouſand peeces of Gold on that undertaking: a munificence truely worthy the Heroick mind of ſo great a Prince, and which well deſerves to be had in perpetual commemoration by all lovers of Learning: but ſomwhat unhappily imployed, in reſpect the Perſons ſet a Work were not ſo ſtrict in ſtudiouſly and conſtantly obſerving, as ſcrupulouſly computing, directing their calculations not ſo much to what themſelves and others had really obſerved, as to certain traditional, myſteries, or Caballiſtical dreams: that we may paſs by their heedleſneſs, which *Regiomontanus* detecting, perceived, that they had miſtaken the true places of the Fixt Stars, by very neer two whole degrees; as accounting the numbers of *Ptolomy*, as if they had bin conſtituted by him from the beginning of the Years of Chriſt. Which conſidered, we have the leſs reaſon to wonder, if the Tables compoſed by them, called from the Kings name, the *Alphonſive*, and ſometimes from the place, where they were made the *Toletane Tables* (whence alſo He, who was Preſident of that aſſembly of *Aſtronomers*, is ſaid to have been one *Iſaac Chanter* of the *Toletun* Synagogue) have been found, ever ſince the time of K. *Alphonſus*, to diſagree with the Heavens, and to require the review and caſtigation of ſome new and more faithfull hands. Thence forward *Aſtronomy* lay neglected, and almoſt buried in oblivion, (only *Thebitius* an *Arabian*, and *Prophalius* a *Jew*, obſerved in the mean time ſome ſmall matters, about the motion of the Fixt Stars, and the obliquity of the *Ecliptick*,) untill about two hundred Years ſince, *Georgius Peurbacchius*, and *Joh. Regiomontanus*, his diſciple, ſeemed to revive it. For, theſe worthy men delivered it out of the double cloud of ignorance and vanity, which the *Arabians* and *Jewes* had raiſed, to the Obſervation of its luſtre; and kindled the Light thereof afreſh in *Germany*: reducing *Ptolomy*, providing Inſtruments, and making not a few faithfull Obſervations: though they were not ſo happy, as to bring their deſigne to that perfection they hoped and had propoſed to themſelves; both of them dying in the middle and flower of their Age.

*after whom, the Science lay neglected. till,* Georg. Peurbacchius *and* Joh. Regiomontanus *aroſe, and again ca'vated the ſame.*

Articl. 12. *Then followed the m ſt accute* Nich. Coper.

Animated by their example, *Nicholaus Copernicus* (a *Boruſſian* born, and *Canon* of the *Cathedral Church* of *Warmes*, ſcituate neer *Fruemburgh*, in the ſame Country) about the beginning of the laſt Age,

Age, seriously addressed himself to the Illustration of *Astronomy*; and reviving the long neglected *Systeme* of the World excogitated by *Pythagoras*, he made many good Observations, in order to the composing of new Tables But, forasmuch as he could not determine any thing concerning the Fixt *Stars*, besides their Promotion Eastward, which they appeared to have made since *Ptolomy's* time; he therefore composed some *Canons* of their motions, and those as exact as possibly he could: yet both those, and the *Prutenick Tables* that were built upon them, were incorrespondent to the motions of the Heavens, though less incorrespondent than the *Alphonsine*. Nevertheless, the man is to be highly commended, both for his sublime perspicuity, and modesty, in that foreseeing his Canons would need correction, he was wont frequently to exhort and encourage that ingenious young man, *Georgius Joachimus Rheticus*, deeply enamoured of the beauties of *Astronomy*, to apply himself principally to the Restitution of the Fixt *Stars*, and chiefly of those, which were in the Zodiack, or neer it, and with which the Planets might be most conveniently compared: because, without their restitution, it was impossible either to attain to the true places of the Planets, or to atcheive any thing of Moment or certainty, toward the advance of *Astronomy*.

nicus, *who revived the dotrine of* Pythagoras, *concerning the Earths motion.*

And then at last enters that Noble *Dane*, *Tycho Brahe*, upon the Theatre of *Astronomy*. Who, as by in the impulse of his Genius, being addicted to beholding and noting the *Stars*, even almost as soon as he saw the light of them; was so much the more spurred on by that advice of *Copernicus*, published in the Works of *George Joachim* newly mention'd, by how much the more clearly he discerned the impossibility of determining the true and proper place of that famous New Star, (appearing in the Constellation of *Cassiopeia*, from the beginning of November, in the Year M. D. LXXII. for above sixteen months together) without the restitution of the Fixt *Stars* to theirs. For, He plainly perceived, that most, if not all the Errors, which had bin found in *Astronomy* even from its first foundation or original, took their rise chiefly from hence, that the Fixt Stars really were not in those places, in which they were supposed to be, by Observators; But some of them were much neerer, and others again as much farther off; and this, whether because *Hipparchus* in the beginning had not with due exactness consigned all the Fixt Stars

Articl. 13. *And last of All, the noble* Tycho Brahe, *who out-did all the rest in discoveries and inventions.*

to peculiar places, which indeed he had deſigned by the Sextants of degrees (and truely it is very difficult at once to invent any thing of Moment, and perfect the invention) or whether becauſe the Tranſcribers of *Ptolomy*, out of careleſneſs, or ignorance, had corrupted the Original Text in many places; or whether the additions afterward made, in reſpect of the *Stars* progreſs to the following *Signes*, had occaſioned any miſtake and imperfection in that Theory; or whether by any other unhappy cauſe whatever. Now, in Order to this great Work, of rectifying thoſe fundamental Errors, it pleaſed Fate, that about the very ſame time, that truely generous and never enough commendable Prince *William Landgrave* of *Haſſia*, had zealouſly devoted his mind and induſtry to the ſame care, of reſtoring the Fixt *Stars* to their true manſions: but yet the honour he aimed at, was decreed only for the incomparable *Tycho*; who in an Heriocal bravery of *Soul*, had now reſolved with himſelf to enterpiſe no leſs than the Inſtauration of the whole *Science* of *Aſtronomy* from its very fundamentals; and ſo to ſpare neither labour, nor coſt (eſpecially while he was ſo happy, as to have good part of his expences defraied by the liberal contributions of that eminent *Mecenas*, *Frederick* the *II.* King of *Denmark*, who thereby recorded his name in immortal Characters on the leaves of Fame) that ſhould be neceſſary to the making all *Sorts* of Obſervations requiſite. As ſoon therefore as he had furniſhed himſelf with that *Aſtronomical* Colledge, or Tower for Obſervations, built by him in the *Iſland* of *Huenna*, to that purpoſe aſſigned him by the King, and furniſhed that Heavenly Cittadel by him called *Uraniburg*, with ſtore of exquiſite and magnificent Inſtruments Mathematical, he begun (having provided himſelf of ſundry learned and competent Coadjutors) exactly to obſerve the Altitude of the Pole, in that place, by the Circum-polary *Stars*. By which underſtanding likewiſe the Altitude of the *Equator*, he pointed out the Equinoctial points, by the paſſing of the Sun through them: and attending beſides to the middle parts of *Taurus* and *Leo*, he found out the *Apogæum* of the Sun, and the Eccentricity of it, and deduced its Courſe from the point of the *Vernal Equinox*. Moreover, from *Venus*, in the Day time compared with the *Sun*, and in the Night with the Fixt Stars; he endeavoured to ſearch out the right Aſcenſions, and Declinations of the *Fixt Stars*: which the Ancients had per-

formed, but fallaciously, by using the Moon, not *Venus*, to that purpose. And his success was as exquisite as his care in this, that he constituted that bright Star which is in the top of *Aries*, and ranged the chief of those in order along the Zodiack: and then advancing to enquire or rather find out the distances of the rest aswell from them, as each from other, he defined both the right Ascensions and Declinations of all; prescribed their several Longitudes and Latitudes, and added to the Catalogue of the Ancients about 200. other *Stars*, wholly by them omitted. Because the Ancients, Living in an Horizon much more Southern, had observed and set down neer upon 200. *Stars*, that are invisible in the *Danish* Horizon, which is highly Northern: and *Tycho* again collected about 200. more than they could discern; and as being somwhat small, he intermixed them among others of greater magnitude. Further, having in the mean space, alwaies observed the passings of all the Planets through the Meridian, and their several distances from the cheif Fixt *Stars* neerest to them: he laid such sollid foundations, as by them might be exactly known not only the true places of each, but also their several Motions. So that he came very neer the heighth of his noble hopes of building the whole Theory of *Astronomy* anew from the very ground, and of erecting compleat and everlasting Tables for Calculation thereupon: but, alas! prevented by an immature death, He could not accomplish his designe. It was very much, however, that He went so far, as to have recorded and bequeathed to Posterity such excellent Observations, by which *Kepler* was soon after enabled to compose an intire Theory, and make the Tables called the *Rudolphine*; and by which, and others afterward contriveable, whatever can be desired in these Tables, may be fully supplied and perfected. And this among the rest deserves singular commendations, that He left us the Fixt *Stars* re-installed in their true mansions: wherein He alone, in few Years practice, performed and finished that prodigiously great Work, which no man, from the Dayes of *Hipparchus*, had either attempted, or in any measure advanced.

I pass by many other admirable discoveries of his; as that he was the first, who demonstrated all Comets to be carried freely through the Etherial Spaces; that Refractions ought to be carefully considered and allowed for, and how; that he perceived that the *Latitude* of the Moon ought to be augmented by more

than a Quadrant, or fourth part, than had been conceived; that He almoſt demonſtrately convinced the Latitudes of the Fixt Stars to be varied; that he excogitated an *Hypotheſis*, which all thoſe, who cannot allow of the *Ptolomaicall*, or fear to allow the *Copernican*, may well adhere to and defend; with many other things, as difficult in their Invention, as excellent in their uſe. And obſerve only how vaſtly he tranſcended all that went before him, in point of exactneſs and certainty. As for *Inſtruments Mathematicall*, it is well known, He made ſuch, as for the condition of their matter, for the Vaſtneſs of their magnitude, for the variety of forms, for the care of their elaboration, for the preciſeneſs of their diviſions, and for the facility in uſing; as the World had never the like before. Again, ſo prodigious was his and his Coadjutors ſubtility, diligence, induſtry; that whereas the Obſervations of *Hipparchus*, *Ptolomy*, and all others before him, had bin marked out only by the Sixth or at moſt by the twelfth parth of degrees; he deſigned all his by the ſixtieth parts of degrees, called Minutes, or Scruples, and very often alſo by ſubdiviſions of Minutes. So that we may well demand what compariſon can be made betwixt that groſs way found out by *Eraſtothenes*, and approved and followed afterward by *Hipparchus* and *Ptolomy*, for the Obſervation of the Obliquity of the Zodiack; and that moſt fine and exact one invented by *Tycho*? His being, by a diviſion of the Meridian into 83. parts, and the Interval of the Tropicks deprehended to take up 11. of them, it appeared that the diſtance of one Tropick from the *Equator*, amounted to 5. of thoſe parts and an half, or, by a reduction of them again to degrees, of 23. degr. 51. Min. and $\frac{1}{3}$: and theirs, being by an hollowed Hemiſpear of Stone, with a Gnomon erected in the middle, as we have formerly deſcribed it; and to what degree of ſubtility and exactneſs this way of commenſuration could arrive, the meaneſt Novice in *Aſtronomy* may ſoon judge. That *Quadrant* likewiſe of *Ptolomy*, ſo much admired by ancient Authors; Pray, How vaſtly ſhort did it come of the perfection of the leaſt that *Tycho* uſed? And the ſame may be ſaid of his *Rules*; for, that thoſe *Armillæ*, ſet up by *Ptolomy* in the entrance of *Alexandria* had any thing in them comparable to thoſe erected by *Tycho*, in his *Uraniburg*, cannot in the leſt meaſure be argued from the other Inſtruments then in uſe. It is not neceſſary, we ſhould here again review thoſe machinaments, or engines, which the

the old *Egyptians* and *Babylonians* made use of, either in discerning the Signes of the *Zodiack*, or taking the Diameter of the Sun: or those, which *Aristarchus* and *Archimedes* used, for commensurating the same Diamater. Only we cannot but wonder, by the by, how *Aristarchus*, having aimed so neer the white of truth, in the matter of the Suns Diameter, and determining it to be the 720th. part of the Circle, or half a degree; as is delivered by *Archimed*: should yet err so widely in his Book of *Magnitudes* and *Distances*, as to make the Diameter of the Moon (which in truth, is very neer as great as that of the *Sun*) to be the 180th. part of the Circle, or 2. degr. when he called it *the Fifteenth part of a Signe*; which mistake of his was long since taken notice of by *Pappus*. Nor is there any necessity, why we should survey those Instruments, that *Albateginus*, *Peurbacchius*, *Regiomontanus*, *Copernicus*, and other more moderne *Astronomers* used: considering, that besides the *Rules* made by *Regiomontanus* (which *Bernardus Waltherus*, his disciple, preserved, and had recourse to, in his Observations of the *Suns* Altitude) they came so short of the least of *Tychoes*, in point of exact reasoning, and amplitude, that they deserve rather to be perpetually forgotten, than remembred to competition. However it is seriously to be wished, that the Observations made by those incomparable Instruments of His, may ly no longer concealed from the World (for by singular Providence, they have been hitherto preserved, as *Gassendus* attesteth, *in the Life of Tycho*) but soon be brought to Light. And this aswell for sundry weighty Considerations there alleadged by *Gassendus*; as for this, that not all the Stars, of which *Tycho* hath given a copious Catalogue, in his *Progymnasmata*, may be found reduced to congruous Calculation (in as much as they doe not exactly correspond with the Heavens) and that various Catalogues have been pretended from the same, which are very much different each from other: for all the difficulties hereupon depending may soon be removed, and all mistakes rectified, by having recourse to the Fountain, or Original observations, which will clearly declare, what hath bin already corruptly deduced, and what may be at length carefully and demonstratively deduced from them.

*de Acenar. num.*

And, in the mean while, if *Hipparchus* his memory be so highly and (indeed) justly precious among learned men, for his great merrits in excogitating and framing Instruments, whereby to take the dimensions, distances, motions &c. of Heavenly bodies:

dies: certainly, that of our *Tycho* ought to be as highly eſteemed by us and all Poſterity; ſince he alone, for ſo many Ages together was found, that durſt not only imitate him in thoſe ſublime inventions; but ſo imitate, as very much to exceed him. For my part, truely; ſince *Hipparchus* may rightfully be called *Atlas the Second*: I ſhall doe but juſtice to name *Tycho, Hercules the Second*, who releived his Predeceſſor, long languiſhing and ready to faint under ſo prodigious a burden; which doubtleſs was the Reaſon, why *Kepler* called him, the *Modern Hipparchus*.

And thus have we in a ſhort Relation, rehearſed to you, what we could gather together, concerning the Original, Progreſs, and Advance of *Aſtronomy*, from the higheſt of times, of which there remain any Authentick memorials, down to the deceaſe of *Tycho Brahe*, the Noble and the Great. As for what *Additions* this excellent Science hath received, by the induſtry of *Aſtronomers* in this preſent Age, by the help of the *Teleſcope*, whoſe Invention may ſeem to have been unhappily deferred too long, as being deferred till ſome Years after *Tychoes* death: they may be eaſily ſummed up. For, all that our Dayes can juſtly challenge the honour of diſcovering, is (1.) the ſpotts in the Sun: (2.) the inequality of the ſuperficies of the Moon: (3.) *Venus* ſhifting her apparences, as doth the Moon: (4.) *Mercury* and *Jupiter*, in ſome Proportion, doing the like: (5.) *Jupiter* with a kind of bound about him, and guarded with four leſſer Stars, as Attendants: (6.) *Saturn* triple-bodied: (7.) the *Gallaxy* fully beſet with ſmall Stars: and (8.) divers pale aſſemblies of very ſmall Stars, ſeeming to be only little white clouds in the *Welkin*; with ſome other particulars lately remarked. Now, if you pleaſe to add this to the former ſummary: you have the whole (though brief) Story of *Aſtronomy*, from its very infancy to that augmented ſtate it now hath attained to: I wiſh I might have ſaid, to its *Full growth and Perfection*. But, alas! that is reſerved for Poſterity.